Working Plan for a Communal Forest for the Town of Ithaca, New York

John S. Everitt

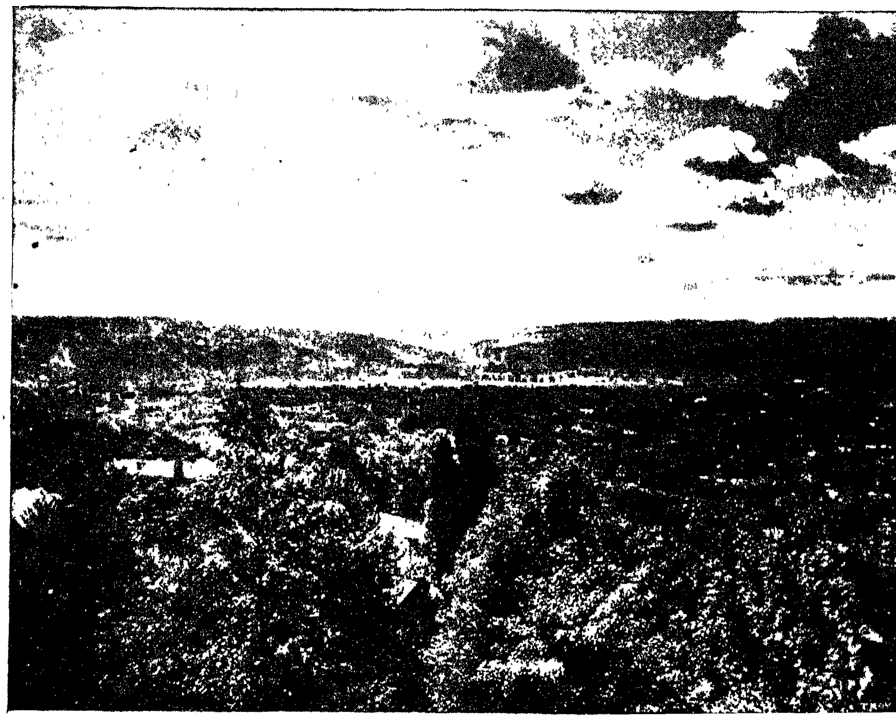

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FIG. 18. BUTTERMILK FALLS, FROM STATE ROAD

WORKING PLAN FOR A COMMUNAL FOREST FOR THE TOWN OF ITHACA, NEW YORK

John S. Everitt

An attempt to establish a national program of forestry is being made in this country at the present time. Some action of this kind is necessary if our forests are to meet the demands of the future. A majority of the States are helping by acquiring forest lands and using them for forestry purposes. Towns and villages can aid the movement in a similar manner and at the same time benefit themselves. In the vicinity of nearly every town and city there are waste and denuded areas which are yielding little or no returns. A large part of these areas could be acquired by the public and could be made productive through the practice of forestry.

In Europe communal or town forests have been established for a long time (Fernow, 1911)[1]. One of the best examples of a successful city forest is that of the city of Zurich, Switzerland, which has been under management since 1309 and has an area of 2840 acres. It has been developed to such an extent that it now yields the city an average annual income of nearly $20,000, or about $7 an acre, besides furnishing employment the year round to about eighty-five men.

Previous to the last decade practically no communal forests were in existence in this country. Several towns in New York have acquired forests, mainly, however, for the protection of watersheds. The city of Rochester has undoubtedly one of the best forest and water-supply plans in the State. This city has some 3000 acres of land within the watershed, on which it has been planting conifers since 1902. Several other cities have acquired forest lands, but up to the present time no systematic forest management has been applied to them.

In 1912 New York State recognized the fact that there were large areas of unproductive land within its boundaries which could be made productive, and a law providing for the acquisition and development of forest lands by counties, towns, and villages went into effect (Recknagel, 1913). Up to the present, little advantage has been taken of this law. The timber needs of the country have brought out very forcibly the need for forest conservation, and various towns are now taking up the question of communal forests.

Otsego County is planning to acquire lands for forestry purposes. The town of Unadilla in that county plans to buy land which is at present

[1] Dates in parenthesis refer to *References Cited*, page 85.

unproductive and plant it with valuable timber species, so that, instead of getting little or no taxes, the town may receive a fair income from this land. Other counties and towns will undoubtedly follow suit. It seems appropriate, therefore, to give the methods of management which could be followed for a communal forest, and to exemplify these methods by a detailed plan of management for a forest in the town of Ithaca.

GENERAL CONSIDERATIONS

Kind of land best suited for a communal forest

Land should be put to the purpose for which it is best suited. Land for a communal forest should be essentially forest land, that is, land which is of little value for agricultural purposes but is capable of growing trees. This would include waste and denuded areas, abandoned fields and pastures, and, most important of all, land needed for the protection of watersheds. A good supply of pure water is one of a town's best assets, and this can be assured if the watershed is kept properly forested.

Size of area necessary

The size of the area will vary according to local conditions, such as the amount of suitable land available, the value of the land, the local interest in the project, and the funds that can be made available for the purpose. The ultimate aim of every town should be to acquire an area of at least 1000 acres. At the start smaller areas may be acceptable, but as public interest is aroused this area should be increased.

Cost of land for a communal forest

Land suitable for use as a communal forest should seldom cost more than $10 an acre, and generally the cost would be considerably less than this. The Otsego County Improvement Association figures the average value of the land it is acquiring for forestry purposes at $7 an acre.

Method of acquiring lands

A law for the acquisition and development of forest lands by counties, towns, and villages of New York went into effect in March, 1912.[2] Under the provisions of that law a county, a town, or a village may acquire, by purchase, gift, lease, or condemnation, tracts of land having forests or tree growth thereon or suitable for the growth of trees.

The first land which should be taken under consideration is that of the watershed area. If title to this cannot be acquired by the town,

[2] Chapter 74, Laws of 1912.

an amicable arrangement with the water department may be made for the use of the land. In case the watershed cannot be acquired or a greater area is wanted, the assessor's lists should be consulted in order to ascertain what lands have been or are about to be sold for taxes. These lands should then be examined, and, if found to be desirable, should be bid in.

In some cases a philanthropic resident may be interested in the matter and may be persuaded to donate the land, leaving it as a monument to himself. Under the law of March, 1912, such a gift is legal, and it provides one of the quickest means of getting a successful start.

If the governing board or selectmen can be sufficiently interested and the proposition is shown to be feasible and a good investment, sufficient money may be appropriated to enable the buying of land in the open market. In this way a better class of land can be secured and a better start obtained toward the final development of an ideal town forest.

Development of the forest

After the land has been acquired, it must be surveyed and the boundaries permanently marked. An estimate of the standing merchantable timber is the next step. Then a topographic map must be made, and also a complete forest map showing the location of every brook, swamp, path, road, and trail, the character of timber and other growth on the land, and the areas needing reforestation. When this work is completed, the forester is ready to go ahead and plan the development and management of the area. In developing the area the work should at first be confined to that part which promises the greatest likelihood of success, leaving the more doubtful sections to a later date, when the success of the project shall be assured. The development and management will be concerned with protection, planting, thinnings and improvement cuttings, permanent improvements, marketing, possible income, and administration.

Protection.— The first and most important consideration in the development of the forest will be the preparing of a plan of fire protection. The survey will show the amount of burnt-over land and the areas where fires are likely to occur. If a railroad runs through the tract, special measures will have to be adopted to guard against this source of danger. As a general rule, the opening up of the forest by roads and trails, the building of fire lines where fires are most likely to start, and the arousing of public interest in the enterprise, will be all that is necessary to reduce the fire danger to a minimum.

Planting.— Planting is sure to play an important part in the development of the communal forest. As a rule, the land which can be acquired for a forest will be in need of planting to a greater or less extent. This will require the making of a careful planting plan designating the areas

to be planted each year and the species to be used. Under the terms of an act of May 5, 1920,[3] trees for planting can be obtained from the New York State Conservation Commission by residents of the State for planting on their own land, simply by paying the express charges. Planting is one of the best means of arousing public interest in the movement, as it is something which the public can see and appreciate.

Thinnings and improvement cuttings.— The area under forest cover on the land acquired for a communal forest will in practically all cases consist of second growth. It will be composed of trees which have come in after lumbering, and will, in all likelihood, be irregularly stocked and composed of inferior species. By a series of improvement cuttings the composition of the forest can be bettered and the trees remaining will make a more rapid growth. In this country such operations bring in little or no money, but in European countries the returns from thinnings and from improvement cuttings form an important part of the gross returns from the forest. Where a good market exists, as should be the case near a communal forest, thinnings should prove an important source of revenue in this country also. Besides the present money value, thinnings improve the aesthetic value of the forest by cleaning it up and making it more traversable.

Permanent improvements.— Both for fire protection and in order to allow the full use of the area for recreation purposes, roads and trails will have to be built. Buildings will be needed for the housing of permanent employees and as a place for keeping necessary equipment.

Marketing.— Each forest will have its own factors affecting market conditions, such as accessibility of the tract, distance to market, and abundance of labor. The ultimate aim of management plans should be the production of material which the forest is suited to produce in paying quantity and for which there is a ready market.

Possible income.— The income resulting from the forest will vary greatly according to local factors, such as the cost of the land, the cost of planting, the cost of administration and protection, logging accessibility, and the distance to market. Lack of sufficiently reliable yield tables and uncertainty of future prices of stumpage make the prediction of future income uncertain. Guise (1916) points out that in a majority of cases white pine can be relied on to bring five per cent or more on the investment.

Administration.— The question will arise as to whether it will be practicable to employ a forester on a communal forest. If possible a trained forester should be in charge, but on areas of less than 1000 acres

[3] Section 50 of the Conservation Law, 1920.

this would be a big financial burden. In any case a forester should be employed in planning the project. Assistance and advice can also be obtained from the State and from the extension departments of forestry schools. In some cases it might be possible for towns or counties to cooperate and employ a forester between them. At least one all-the-year-round man should be employed, especially if advantage is to be taken of the recreational use of the forest. During seasons when the fire situation is serious or when other work is being carried on, additional employees will be required.

DESCRIPTION OF PROPOSED COMMUNAL FOREST FOR ITHACA

The tract proposed as a communal forest for Ithaca is located about one and one-half miles southwest of the city. It lies in the southwestern part of Ithaca Township and the northeastern part of the township of Newfield, and consists of that part of the eastern side of the Inlet Valley lying between Buttermilk Falls and the hamlet of Nina. It is an irregularly-shaped tract about one-half mile wide and three miles long, and has an actual area of 1425 acres.

About one hundred years ago this entire area was covered with an excellent stand of virgin timber. All of this has long been removed, and the forest that remains consists mostly of second-growth hardwoods. In clearing the land the early settlers gave little heed to the agricultural value of the land, and as a result much of the land that was better suited for forest growth was cleared and used for agriculture and for grazing. The soils on the slopes soon lost their fertility and at the present time they are being allowed to revert to forest growth.

The entire tract is privately owned, comprising parts of several farms.

Physiographic features

Topography.—With the exception of a small area of bottom land in the southwestern part, the entire tract occupies a rather steep slope facing west. The elevation varies from a maximum of 1300 feet above sea level, in the southeastern part, to a minimum of 400 feet in the northwestern part. The tract is cut up by several small streams, the main ones (Buttermilk Creek and Lick Brook) cutting deep gorges.

Drainage.—The entire area is well drained by several small streams. In all parts of the tract there is sufficient slope so that no swamps occur.

Geology.—The geological formation is of Devonian origin. The soils, however, are more directly traceable in their origin to the action of glaciers. The shale and sandstone rocks of the region were eroded and the surface material was thoroughly ground. With this finely ground material was deposited later a considerable amount of finely ground

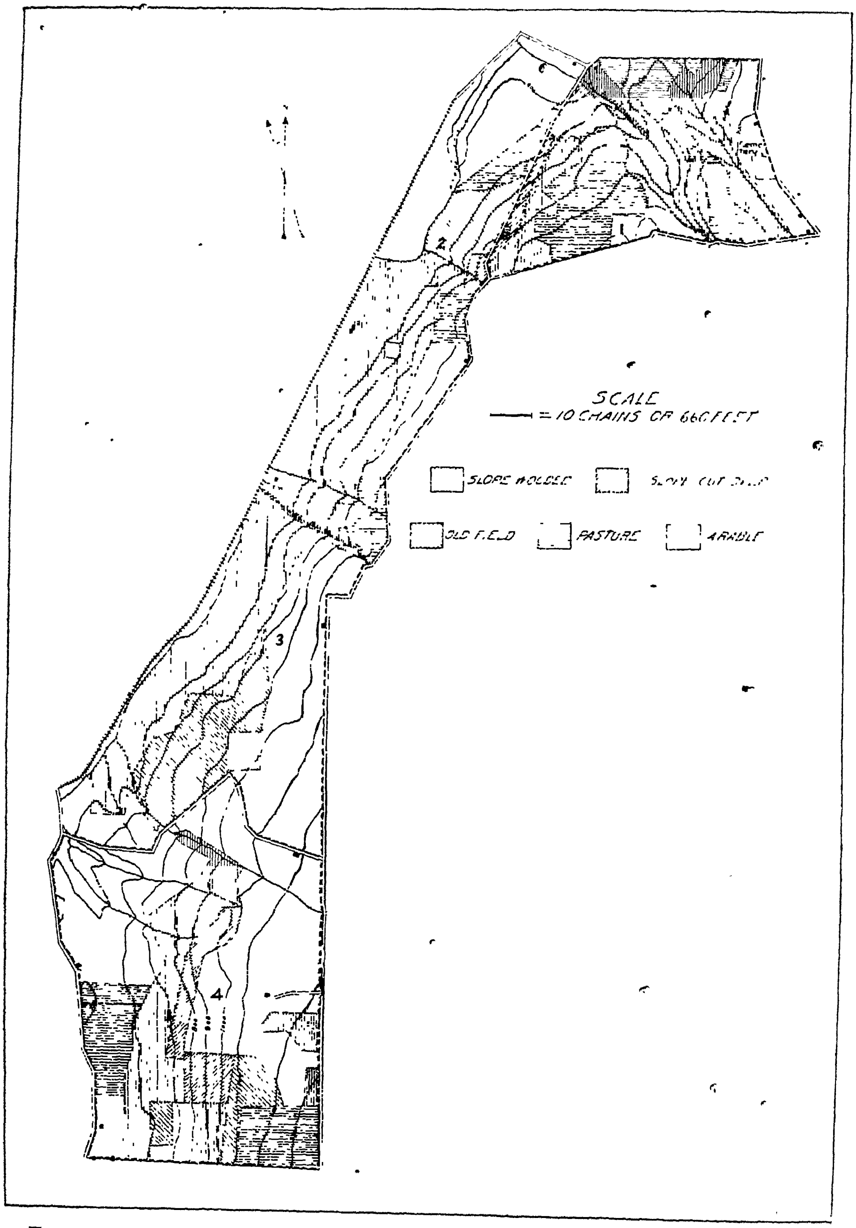

FIG. 19. MAP OF PROPOSED INLET FOREST FOR THE TOWN OF ITHACA, NEW YORK
Topography adapted from the United States Geological Survey

rock material brought in from regions to the north. The soils belong to the Dunkirk series and consist of material from the glaciated uplands which, at the end of the glacial period, was washed down in local temporary lakes and ponds and redeposited as glacial lake or stream terraces (Bonsteel, Fippin, and Carter, 1906). On the gentler slopes the soil is a gravelly sandy loam, while on the steeper slopes there is an excess of shale and limestone, making the land rough and stony.

Climate.— The climate is that which is characteristic of central and western New York. The maximum temperature recorded is 120° F. and the minimum temperature recorded is -20° F., while the annual mean temperature is 47° F. The annual precipitation averages 32.97 inches and is fairly evenly distributed throughout the year. The direction of the prevailing wind is west.

Social and industrial features

Ithaca, with a population of about 16,000, is the only town of any size near the tract. The people are not dependent on the forest for work, fuel, or timber. In ordinary times sufficient labor would be available to carry on any work required on the forest.

Methods of field work

The field work on the proposed forest was performed in the fall of 1916 by students in the Department of Forestry, with Professor S. N. Spring in charge.

The dirt road which branches off from the state road near the foot of Buttermilk Falls was used as a base line. Stations ten chains apart were laid out along this road. The first six strips were run in both an east and a west direction from the base line, while the remainder of the strips lie only to the west of the road. The instruments used in making the survey were a Forest Service compass, a chain tape, an Abney hand level, and Biltmore sticks. A four-man party was used: one man acted as head chainman and compassman; another acted as rear chainman, keeping tally of the number of chains, recording the diameter breast-high of trees by species, and making silvicultural descriptions; the other two men did the calipering. The diameter breast-high of all trees six inches and more in diameter was measured. No topographic notes were taken, the data for the map being obtained from the United States Geological Survey map (Ithaca Quadrangle).

The forest

The types recognized are based on the present conditions or use of the land, and are temporary in character. After the area is planted, permanent types can be recognized, but for the first ten-years period the following types will be used:

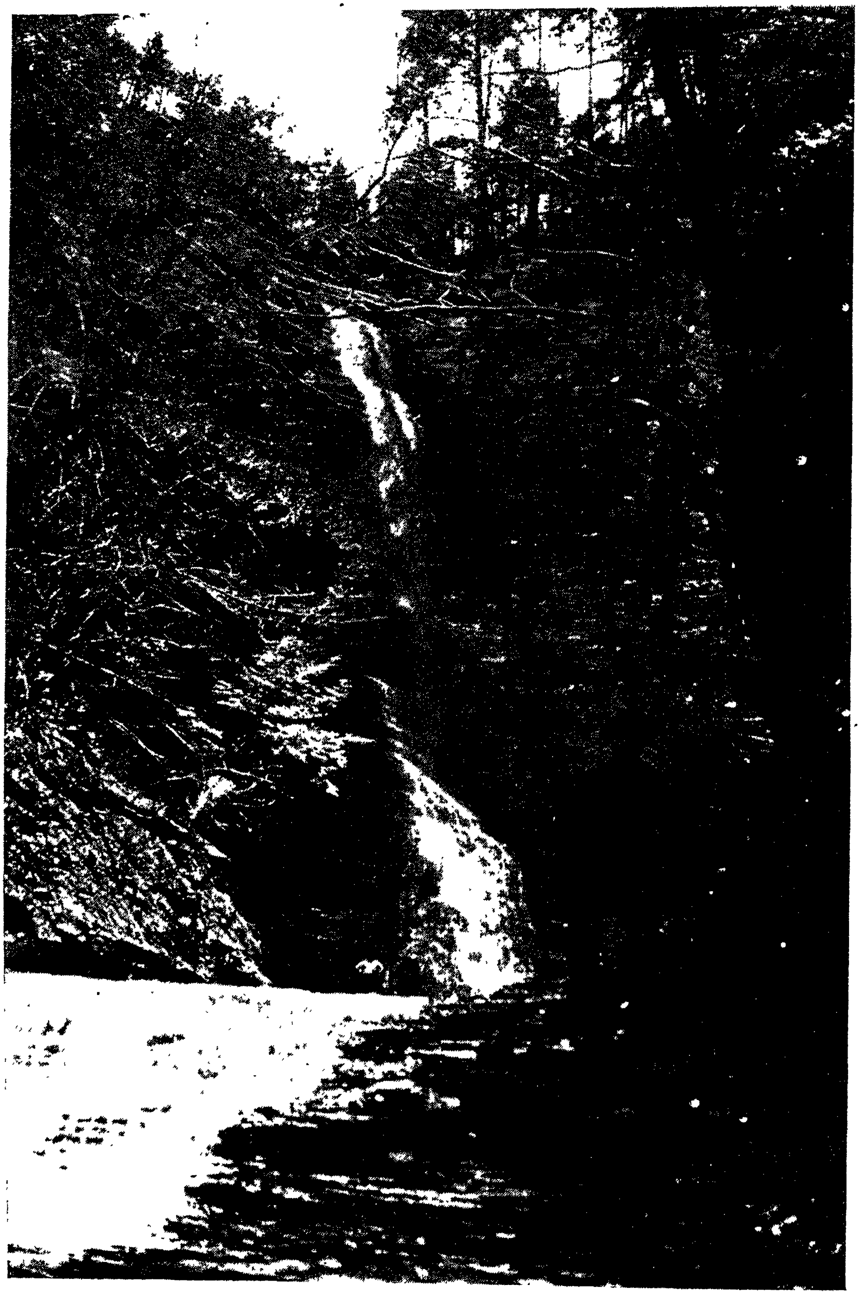

FIG. 20. GENERAL VIEW OF LICK FALLS

(1) Slope wooded. This type comprises the more heavily woode areas. They have been cut over, but at the present time there is conside able merchantable material and any cutting that is done in the first ter years period will be done on this land. There are 482 acres in the slop wooded type.

(2) Slope cut over. This type comprises the areas that have been heavil cut over. Practically all the merchantable timber has been remove and the area is restocking naturally for the most part. There are 4 acres in this type.

(3) Old field. This type consists of fields that have been used fo agricultural purposes or for grazing, but, having proved of little valu for these purposes, have been abandoned and are now gradually revertin to forest conditions. There are 213 acres in this type.

(4) Pastures. This type is composed of those areas which are bein grazed at the present time. Some of them are fair for grazing purposes while the rest are clearly forest land.

(5) Arable. This type constitutes the areas that are being tilled These lie mainly on the upland parts of the tract and could very wel be excluded from the forest. Pasture and arable land together com prise 683 acres.

The following species were recognized and are tallied separately: whit pine, hemlock, white oak (white and chestnut), black oak (black and red) hard maple, basswood, chestnut, ash, hickory, beech, and miscellaneous The species tallied under "miscellaneous" include tulip, cucumber butternut, elm, black birch, poplar, cherry, ironwood, soft maple, cedar red pine, and pitch pine.

Height measurements were taken for each of the recognized species and from these measurements tables for height growth on the basis o diameter were prepared. Satisfactory volume tables for this region ar not available, and so in working up the estimates those volume table which seemed most nearly applicable were used. The volume and heigh data thus calculated for the various species are given in tables 8 to 2 (appendix, pages 92 to 98). In each case the source of the volume tabl is indicated and any deviations which were thought necessary are shown

Data on number of trees and corresponding volume for an averag acre of each forest type are given in tables 1 to 6 (appendix, pages 86 to 91) The estimates of all types are summarized in table 7.

Growth.— Data on local growth are not available, and for a mixe stand such as is found on this tract it would be useless to attempt t apply results obtained in other sections of the country. If forest manage ment is to be practiced, the obtaining of these data is one of the firs problems that must be met.

FIG. 21. SLOPE WOODED TYPE OF FOREST

FIG. 22. SLOPE WOODED TYPE, SHOWING MIXED COMPOSITION OF FOREST AND VARYING SIZE OF TREES

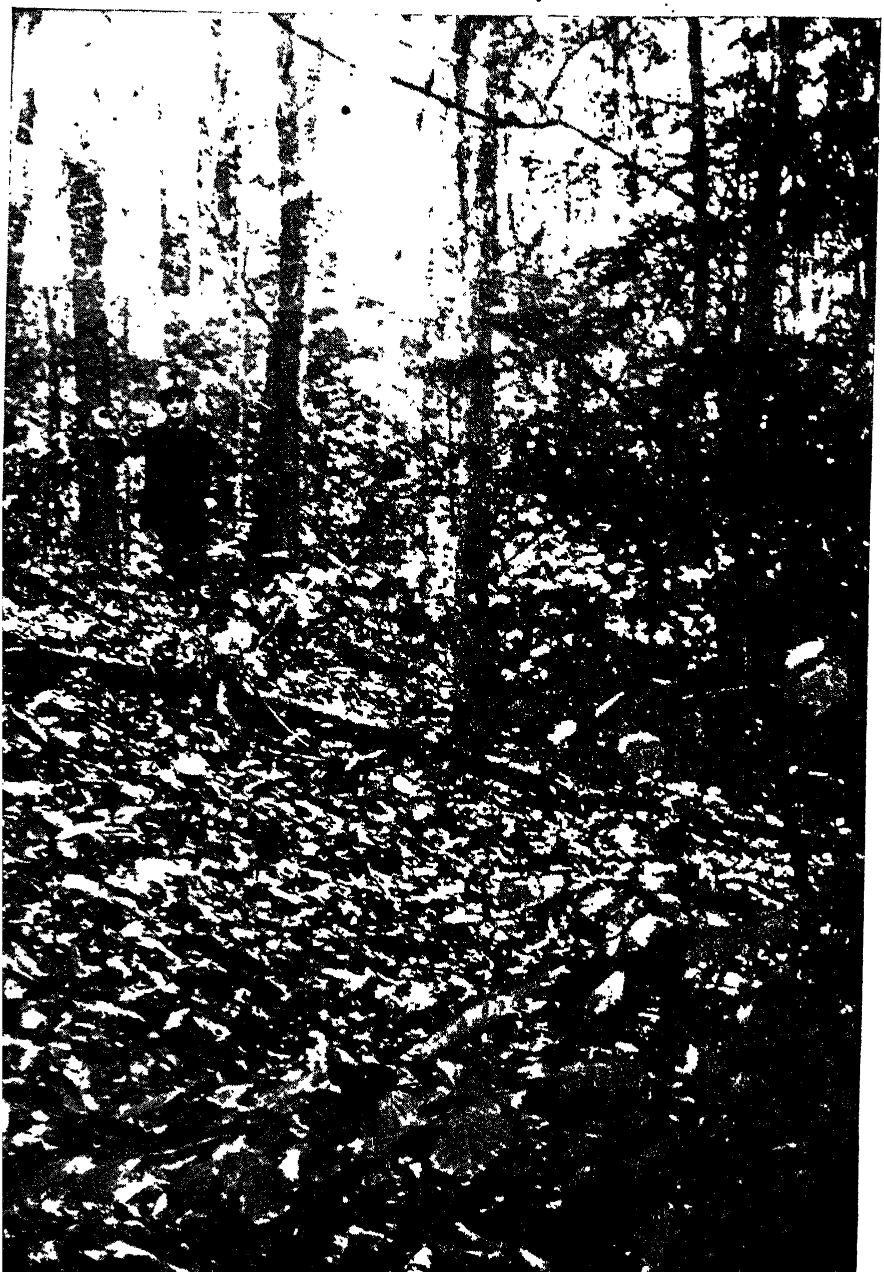

FIG. 23. SLOPE WOODED TYPE, SHOWING UNDERGROWTH

Bentley and Paul (1914) made a study of the rate of growth for white pine near Enfield Falls, and the results of their study are given in table 21 (page 99). This table is of no particular value for the tract under consideration, inasmuch as there are no pine stands. It is included here merely to give some indication of the rate of growth of white pine in this region.

For the increment of hardwoods and hemlock no satisfactory data were available, and therefore no attempt has been made to forecast their rate of growth.

Maps.— The boundaries and topography for the main map (fig. 19) were taken from the United States Geological Survey map for the Ithaca Quadrangle. The map is drawn to a scale of $1\frac{3}{4}$ inches to the mile, with 100-foot contours. It includes all topographic conditions, all the roads and houses, and the five forest types recognized. A supplementary map, in connection with the planting plan, was made. This map (fig. 28) includes the area around Buttermilk Falls, and on it are shown the areas which should be planted during the first ten-years period.

Forest description.— The area covered by the slope wooded type is 482.5 acres. This type comprises practically the only areas on the tract that now have a forest cover. It is composed of the steeper slopes, the ravines, and scattered woodlots.

The soil varies from gravelly clay loam on the better, more nearly level areas, to rough and stony on the steeper slopes and in the ravines. It is clearly a forest soil. In depth it varies from shallow to moderate; as to moisture it varies from fresh to moist.

The leaf litter, as a whole, is rather scant, although on the more heavily wooded areas it would be classed as moderate. Very little humus is found, and where it does exist it is usually in small pockets.

The ground cover also is rather scant. It occurs for the most part in patches, and consists of yew, ferns, moss, wintergreen, blueberry, and small herbaceous plants.

The underbrush is rather scattering and includes such species as sumac, witch-hazel, striped maple, dogwood, alder, blackberry, and raspberry.

The reproduction is fairly abundant. In the ravines it consists, for the most part, of hemlock, with some white pine. The hardwood reproduction is fairly dense in places and is made up mainly of chestnut, oak, (black, red, and chestnut), ash, basswood, maple (hard and soft), and some beech. Its origin is both sprouts and seedlings, with the sprouts predominating.

As shown by table 5 (page 90), the species in order of their numerical importance are: hemlock, basswood, black oak (black and red), hickory, white oak (white and chestnut), hard maple, beech, white pine, chestnut,

ash. The stand is of both sprout and seedling origin and is all second growth. Nearly sixty per cent of the stand is in the 6-, 7-, and 8-inch classes. From stump counts and increment borings the growth was found to be rather slow.[4] The form of the trees as a whole would be classed as poor. The pine shows the effect of weeviling (*Pissodes strobi*) and is limby, and practically all the chestnut is attacked by the chestnut blight (*Endothia parasitica*). The hemlock shows considerable windfall. The merchantable condition would be classed as poor.

The slope cut over type covers an area of 46.9 acres. On this type, cutting has been done more recently and has removed practically all the merchantable material. The conditions of soil, forest floor, and ground cover are in general the same as for the slope wooded type. In fact, under ordinary conditions this type would form a subtype and within a decade or so it would all be managed as one type.

Due to the more severe opening-up of the stand, the reproduction on this type is more abundant. It consists of the same species as are found on the slope wooded type, but the origin is mostly by sprouts. The white pine that has come in is badly weeviled, and the chestnut sprouts have in nearly every case been damaged by the blight.

Sixty-five per cent of the stand is included in the 6-, 7-, and 8-inch classes (table 3, page 88). The larger trees on the area are of poor form and low merchantable value. They are the trees that were either too small or of too little value to be removed when the cutting was made. They are of value in forming a cover and in producing seed to restock the area.

The area covered by the old field type is 212.8 acres. This type is composed of those areas that were formerly used for agriculture and grazing. The soils, however, soon lost their fertility and the fields were abandoned, and now they are slowly reverting to forest. The soils are practically the same as in the two preceding types. There is no leaf litter nor humus. A sod has formed over most of these areas and is of value in preventing erosion. Where these areas adjoin woods, they are being restocked chiefly to white pine, red pine, and pitch pine. Cedar (*Juniperus virginiana*) is coming in more or less thickly in some places.

The area covered by the pasture type is 188.8 acres. This type includes those areas that are at present being grazed. For the most part they are of little value for this purpose and ultimately will revert to forest. Even now, where grazing is not too intensive, white pine and red cedar are coming in.

The arable type covers an area of 494.3 acres. This type includes the land now being tilled. With few exceptions it is found either on the

[4] White oak and black oak trees 12 inches in diameter at breast height were found to be one hundred years old; 14-inch pignut hickories were one hundred and fifteen years old.

more nearly level uplands or in the bottom lands. Some of these areas are of sufficient value for agricultural purposes, so that they would not enter into the plan of management. Some of the poorer areas, however, will soon lose their fertility and will prove more profitable as forest lands.

FIG. 24. OLD FIELD REVERTING TO FOREST
White pine shows weevil damage

FIG. 25. OLD FIELD RESTOCKING WITH CEDAR, ELM, AND PINE
Enfield Glen may be seen across Inlet Valley

Division of the area.— For purposes of management the entire area — the working unit — has been divided into four compartments. The boundaries are shown on the map (fig. 19). The compartments are numbered and named as follows: compartment 1, Buttermilk Falls; compartment 2, Inlet; compartment 3, Lick Brook; compartment 4, Nina. Later it may become necessary to segregate subcompartments, but until considerable planting has been done this is unnecessary.

PROPOSED MANAGEMENT

The proposed forest tract should be managed with the ultimate aim of securing a sustained periodic yield. At the same time it should be so managed that the aesthetic and recreational values will be developed to the greatest possible extent. Nature has done much to aid this part of the plan, and with the help of man this tract can be made to add very greatly to the health, happiness, and prosperity of the town. The market for saw timber and fuel wood is particularly favorable, so that good financial returns from these products are possible.

Practical restrictions

As just stated, the market for practically all kinds of products is exceptionally good. Very close utilization can be practiced. Compared

FIG. 26. OLD CUTTING, SHOWING YOUNG GROWTH OF HEMLOCK AND PINE

with other regions, logging will be comparatively cheap. The area is bounded by good roads, and in most cases the slopes are toward the state road. No expensive logging machinery will be necessary.

The only real fire danger is found on the area along the railroad. The survey indicates that in the past the fire damage has been very slight. Because of the steepness of the slopes, there is always the danger of erosion, but planting will tend to obviate this.

The white pine weevil is the only important insect pest, and chestnut blight is the only serious disease, found on the tract. The chestnut is about ruined and will probably be eliminated within the first ten-years period. Careful consideration will have to be given to the question of increasing the amount of white pine.

Silviculture

Since the aesthetic value of the tract is one of the points to be given chief consideration, the plan of management must be of such a nature that it enhances the appearance of the woods. The only areas that need be considered under the silvicultural management are those included in the slope wooded and slope cut over types. The other areas will be arranged for in the planting plan.

The selection system is about the only silvicultural system applicable at the present time, and this should be more in the nature of an improvement cutting than a strict selection cutting. The cuttings for the first ten-years period should remove the diseased chestnut, and the dead, defective, and poorly formed trees of other species. No cutting should be done in or near the ravines except where it is needed to salvage windfalls or to remove diseased trees. Cutting should be very light along the roads and the trails also.

The pasture lands in compartments 3 and 4 should be fenced off, and, until such a time as they can be planted, should be used for grazing sheep or cattle. In this way they would produce some revenue.

Rotation

The lack of data makes the determination of rotation age largely a matter of approximation. Under the selection system, and especially for the first ten-years period of this working plan, the actual rotation age is not of great importance. Until more data are obtained, a tentative rotation of eighty years should be adopted for all species.

Marking rules

All live trees to be felled should be marked at the base and blazed at diameter breast-high. In selecting the trees to be cut, care should be

taken not to destroy the aesthetic value of the woods. The following rules should be observed in selecting trees for removal:

1. Dead, dying, and diseased trees are to be removed first; also all windfalls.

2. Cutting should be such as to benefit the remaining stand.

3. Trees of poor form and undesirable species should be removed.

4. Along the ravines and along roads and trails, the marking should be light.

Brush disposal

Where practicable, brush should be piled and burned. In any case it should be disposed of in such a way as not to form a fire risk, and at the same time so as not to impair the aesthetic value of the forest. Studies and experiments will have to be made to determine the best time and manner of brush disposal.

Determination of cut

Inasmuch as more than ninety per cent of the stand is under 13 inches diameter breast-high, very little cutting should be done during the first ten-years period. What timber is removed should be for the purpose of preventing the spread of disease and as a means of improving the remaining stand. The working-out of the allowed annual cut becomes therefore relatively unimportant for the present.

Of the eighteen methods of figuring the yield as given by Recknagel (1917), Von Mantel's is the only method that can be used here. This works out as follows:

$$y = \frac{v}{\frac{r}{2}}$$

y = annual cut

v = growing stock = 767,203 board feet of softwoods and 7,105 cords of hardwoods

r = rotation = 80 years

$$y = \frac{767{,}203}{\frac{80}{2}} = 19{,}180 \text{ board feet}$$

$$y = \frac{7{,}105}{\frac{80}{2}} = 178 \text{ cords}$$

The cut for the next ten years should thus not exceed 192,000 board feet of softwoods and 1800 cords of hardwoods. Because of the small size of the softwood timber, it would be inadvisable to remove all of this and it should be allowed to accumulate.

Distribution of cut

The improvement cuttings should begin at the north end of the tract and move toward the southwest. They should be located with particular regard to the needs of the stand, and also with regard to the market conditions.[5]

General planting plan

For the first ten-years period, planting should be confined to the open areas in the vicinity of Buttermilk Falls. For these areas a complete planting plan has been prepared, as outlined in the following pages. At the end of ten years similar plans will have to be prepared for the open areas on the remainder of the tract.

PLANTING PLAN FOR AN AREA IN THE VICINITY OF BUTTERMILK FALLS

Buttermilk Falls, with the surrounding land, is one of the best-known points of interest in the town of Ithaca. It is, moreover, one of the most beautiful, and for this reason and its accessibility it is visited by a great number of persons. But aside from its scenic beauty, it has a real value to the town of Ithaca which apparently is not yet fully realized. This value lies in the exceptional opportunity offered for a community forest. The land in itself is natural forest land unsuited for agriculture. From the evidence on the tract, it is capable of supporting an excellent stand of timber which would serve not only to add to its attractiveness from the standpoint of the tourist, but also as a source of income. As a step toward the improvement of the tract as outlined in the preceding pages, the Department of Forestry at Cornell University has prepared this planting plan for the land in the vicinity of Buttermilk Gorge, as a part of a working plan for the entire tract.

General description of the area

The area in question lies approximately one and one-half miles south of the Ithaca city line, on the fairly steep west slope of a ridge forming the eastern boundary of Cayuga Basin. It is cut by two deep gorges, the more prominent being that known as Buttermilk Creek Gorge, and the other, unnamed, lying about one-quarter mile to the north.

The area is bordered on the west by good agricultural land extending along the foot of the slope. For several hundred feet to the east it rises steeply, then assumes a more gentle slope to the top of the ridge, where it again grades into agricultural land.

The two gorges and part of the steep western slope are either stocked or restocking. There are several relatively large areas, however, which,

[5] Owing to the character of the fellings during the first ten-years period, the preparation of a formal cutting plan would serve no useful purpose.

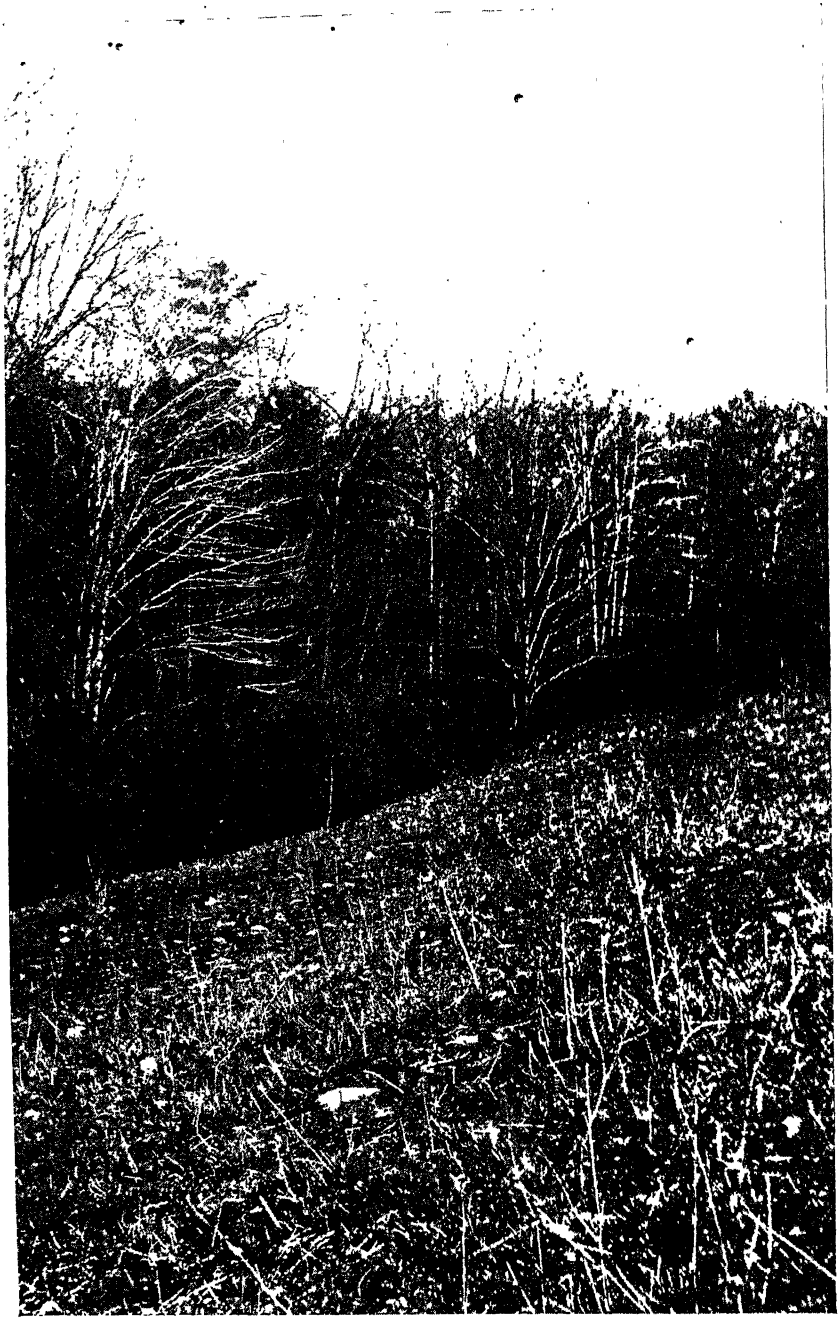

FIG 27. WOODED SLOPE, SHOWING MARGIN OF YOUNG WHITE PINE AND ABANDONED PASTURE IN FOREGOUND

with the exception of a few scattered mature trees and young growth, are devoid of forest growth or underbrush of any kind. These areas are admirably suited for artificial reforestation. Their location is shown in figure 28.

The above-mentioned areas in need of planting occur in the pasture type, which includes, in general, all the open lands in the vicinity of Buttermilk Creek. The soil is a Dunkirk gravelly sandy loam, fairly moist and moderately deep. Litter and humus are absent. The ground cover consists for the most part of grass, with a few scattering weeds. The underbrush is scanty and would not interfere with the planting operations. Where it does occur, it is composed of sumac and, to a less extent, several species of Rubus.

The species chosen for planting are those that give promise of producing the highest financial returns under local conditions, and the plan for the arrangement of the plantations has been worked out with a view to improve the aesthetic value of the tract. No hardwoods were selected, inasmuch as there are already present on the tract sufficient hardwood stands to supply the market with cordwood. The coniferous species selected are those that produce higher-grade material in greater quantity, and at the same time are of greater value for aesthetic purposes.

The species selected for planting are red pine (*Pinus resinosa*), white pine (*Pinus strobus*), scotch pine (*Pinus sylvestris*), norway spruce (*Picea excelsa*), and to a very limited extent European larch (*Larix europaea*).

Planting sites

On the basis of topography, the land available for planting may be conveniently divided into three planting sites, comprising a total of 136 acres. These are designated on the map by roman numerals.

Site I, area 29 acres

Site I is triangular in shape and lies on a steep northwestern slope forming the western boundary of the tract. The soil is deep, moist, and of good quality. On the basis of the distribution of underbrush and young tree growth, it is subdivided into two planting areas.

Area A, 14 acres.— As Area A is the most conspicuous area on the tract and tends to brushiness, it has been decided to use on it a fast-growing species planted in carefully-laid-out rows running east and west. Scotch pine is the species selected. The trees should be spaced 6 by 6 feet.

Area B, 15 acres (net planting area).— Area B is covered with groups of underbrush and young tree growth. It is therefore suggested that groups of scotch pine and larch be interplanted in the openings, for the purpose of supplementing natural regeneration already present and to give a

blending of conifers and hardwoods when the stand grows up and merges with the adjoining natural forest.

At the same time that this area is being planted, the acre of open land near the house on the east side of the road may be set with trees under the same plan as that for Area A.

Site II, area 53 acres

Site II comprises the open land lying to the south of Buttermilk Creek. It is subdivided into two planting areas.

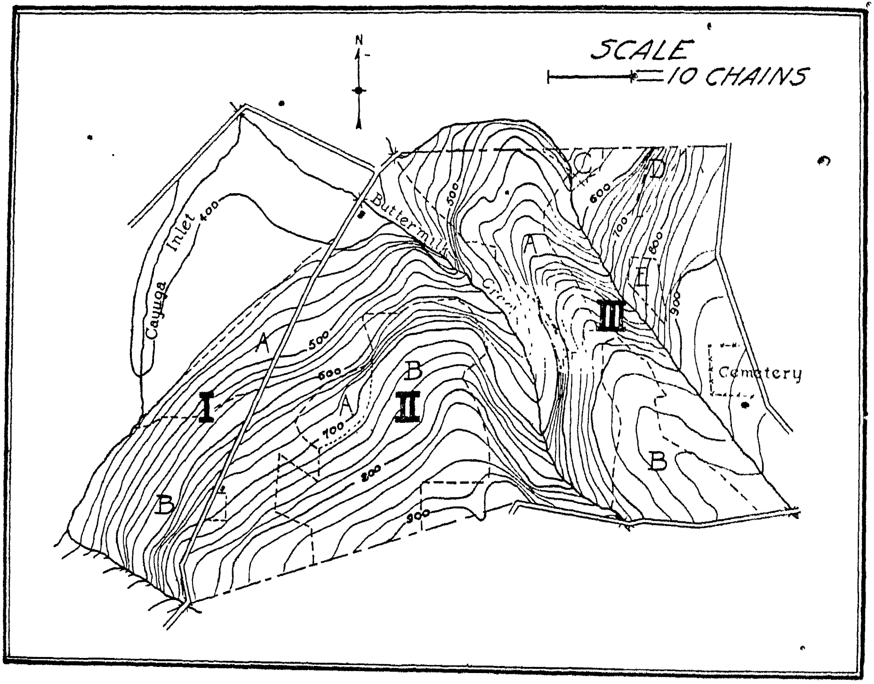

FIG. 28. PROPOSED PLANTING AREA IN THE VICINITY OF BUTTERMILK FALLS

Area A, 5 acres.— The soil on Area A of Site II is slightly better than is found on the other sites. It is therefore planned to plant norway spruce for experimental purposes. The spacing is to be 5 by 5 feet, with the rows running east and west.

Area B, 48 acres.— Area B has slopes with three different aspects — west, north, and east — the largest and steepest being the north and west slopes. The ground is covered with a heavy sod, but has very little underbrush. The species to be planted is red pine, pure, with a 7-by-7-foot spacing. Planting should be so done that the rows run up and down the

slopes, but on the more nearly level part near the center of the area they may run east and west.

Site III, area 54 acres

Site III, with the exception of three small areas, lies between the two gorges. A heavy sod forms the ground cover. The presence of numerous small stones may slightly interfere with the progress of planting. This site is subdivided into five planting areas.

Area A, 26 acres.— Area A of Site III slopes irregularly to the north and west. It is recommended that red pine, pure, be planted with a spacing of 7 by 7 feet. For convenience in planting, the rows should run up and down the slopes, as in Area B of Site II.

Area B, 20 acres.— The presence of large stumps in Area B may necessitate irregular spacing in part. It is flatter than Area A, but otherwise identical with it. Red pine and white pine should be planted in alternate rows with a 7-by-7-foot spacing, the rows running in an easterly and westerly direction.

Area C, 2 acres, and *Area D, 3 acres.*— The northern boundary of the tract, arbitrarily fixed as shown on the map, cuts off the two small areas C and D. They should both be planted with red pine, the trees being spaced 7 by 7 feet and the rows running up and down the slopes.

Area E, 3 acres.— Area E is a small area lying to the south of Areas C and D, and should be similarly planted.

Summary

The foregoing recommendations for sites may be summarized as follows:

Area	Species	Number of trees	Total number of trees
Site I			
A. 14 acres	Scotch pine	16,940	
B. 15 acres	Scotch pine	13,620	
	European larch	4,530	35,090
Site II			
A. 5 acres	Norway spruce	8,710	
B. 48 acres	Red pine	42,672	51,382
Site III			
A. 26 acres	Red pine	23,114	
B. 20 acres	Red pine	8,890	
	White pine	8,890	
C. 2 acres	Red pine	1,778	
D. 3 acres	Red pine	2,667	
E. 3 acres	Red pine	2,667	48,006

Number of trees required, by species

Red pine	81,788
White pine	8,890
Scotch pine	30,560
Norway spruce	8,710
European larch	4,530
	134,478

Source of stock

Planting stock may be obtained from the State Conservation Commission at Albany, New York. Orders should be placed well in advance to insure having the stock on hand when needed.

It might prove of advantage to cooperate with the Department of Forestry at Cornell University and procure trees from the department's nursery, thus eliminating certain disadvantages of having the material shipped. Expert advice in the handling and care of the young trees could likewise be obtained from the department.

Preparation of sites and preliminary protective measures

The sites will require no preparation for planting, but there are several preliminary protective measures which should be taken. The first and most important is that of excluding all stock from the plantations. This will necessitate extensive repairs to the fences and walls, and the construction of new fences where needed.

Either before or soon after planting the white pine on Area B of Site III, all plants of the genus Ribes growing on the site and within 300 feet of it should be destroyed. The best method is to pull the plants up by the roots and hang them on near-by trees or underbrush, so that there will be no danger of their taking root again. This is to guard against the infection of the young white pine trees by white pine blister rust.

Planting instructions

Immediately upon receipt, the plants should be transported to the planting area and heeled in in a well-drained soil. To properly heel in the plants, an open trench should be dug with the wall sloping slightly from the vertical. The plants should be arranged in an upright position in a thin layer against this wall. Soil should then be piled against the roots and the lower part of the stems, and carefully worked in between them with the fingers and firmed with the feet. The plants should be shaded.

When ready for planting, the trees should be placed in pails with a layer of damp moss around the sides and bottom to prevent the roots

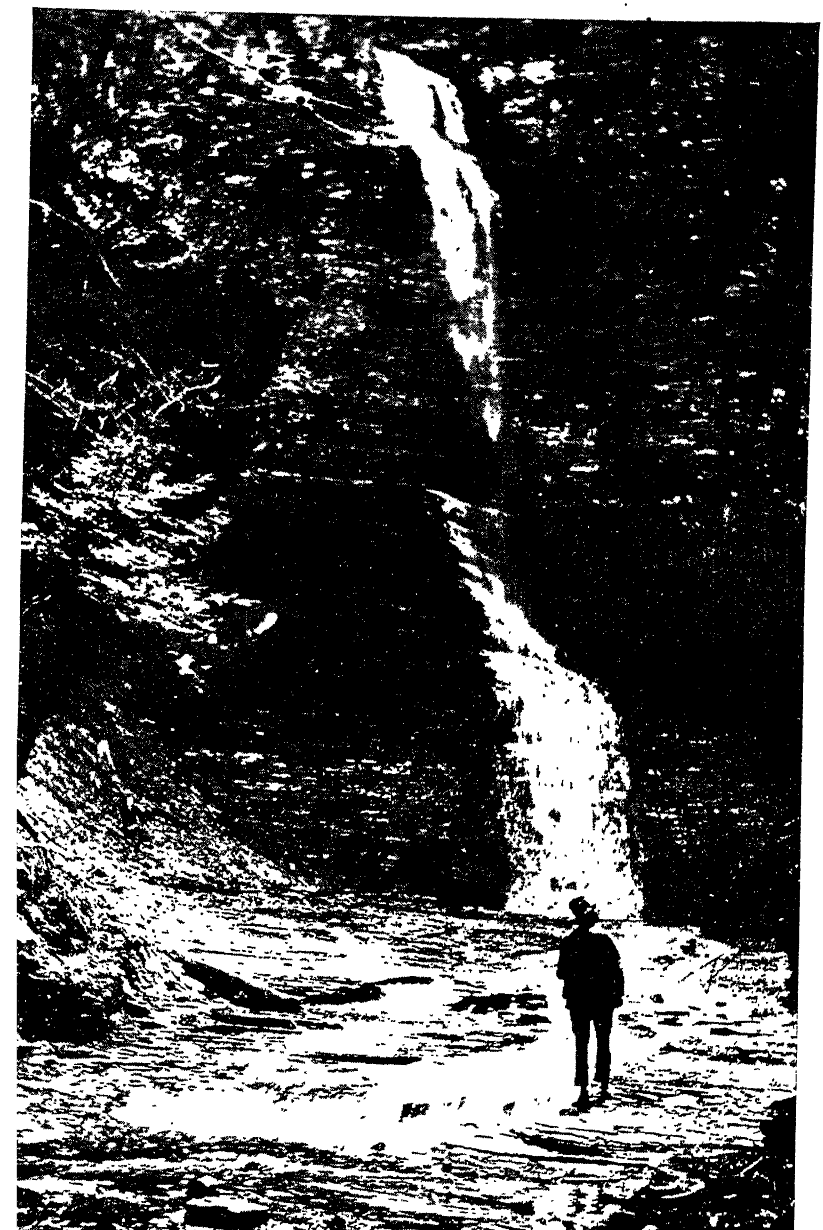

FIG. 29. THE FALLS OF LICK BROOK

from drying-out. The planters should work in crews of two, one man digging the hole with a grub hoe, the other following with a pail of trees and planting them. The man in charge should carefully instruct each crew as to the proper method of digging the hole and setting the trees.

Future treatment

Except on Area B of Site I, no cleanings would probably be necessary during the first ten-years period. Fires should be strictly excluded from the tract. There are no special measures for fire prevention to be recommended in this plan, however, other than the posting of fire notices. The planted area should be inspected at least once a year for indications of insect damage and fungous disease.

Financial considerations

Planting will cost about $10 an acre.[6] Taking into account the cost of the land and of planting, taxes on land and timber, and a small charge for protection, and assuming that the stumpage will be worth $500 an acre in forty-five years, a rate of interest will be earned which will be equivalent to about 6½ per cent compound.

ADMINISTRATION PLAN

Field administration

The employment of a trained forester on an area of this size would be a heavy financial burden. The general supervision and planning for the management of the tract could well come under the Department of Forestry at Cornell University. One all-the-year man would be required on the ground. He would have charge of the entire area and would be responsible for the carrying-out of the plans for management. During the planting season, when cutting is being done and when other special work is required, laborers would have to be hired and these would work under the direction of the regular man. This scheme would be sufficient for at least the first ten-years period.

Forecast of receipts and expenditures and net income for ten-years period

A forecast of receipts and expenditures for the first ten-years working period is difficult. The receipts that might be expected would be mainly from the sale of the cordwood which would be obtained from the improvement cuttings. For the ten-years period this should not exceed 1800 cords, and it can thus be seen that at first the receipts would be relatively small. A small income could be obtained also from the rental of the better

[6] This includes all costs except for the trees, which are to be procured from the New York State Conservation Commission under the Free Tree Act.

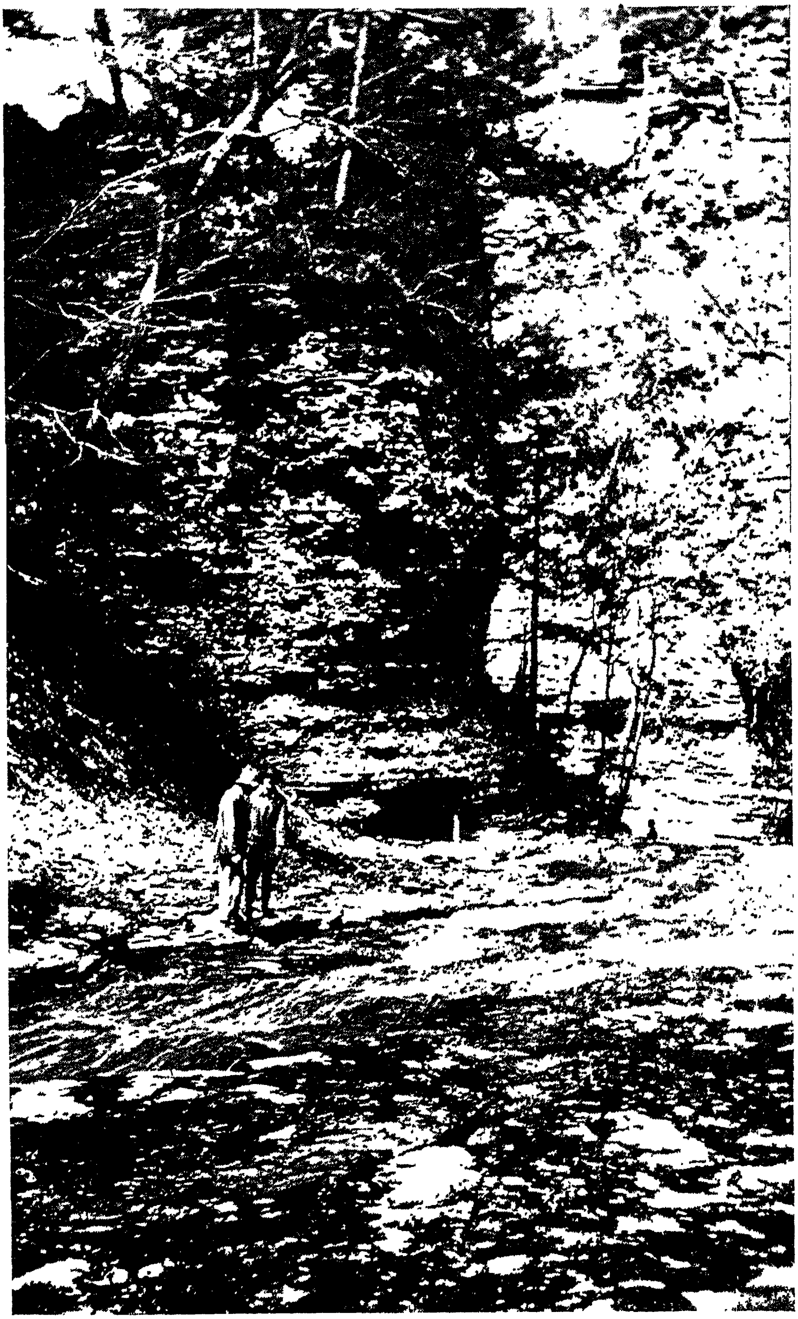

FIG. 30. THE GORGE OF LICK BROOK

grazing land in compartments 3 and 4, but during the first ten years the forest would be a matter of investment rather than of income; it would have to be made productive by improvement cuttings and by planting before it could yield a substantial revenue.

The main expenditures would be for the employment of the forest ranger in charge of the tract, and the costs of planting. The building and improvement of trails through the ravines, and the establishment of places suitable for picnic parties, would also be an expenditure, but much of this work could be done by the forest ranger.

By furnishing a house, of which there are several on the tract which are suitable, a man could be employed for about $1000 a year. The cost of planting would vary with the price of labor, but with the trees furnished free of charge it should cost not over $10 an acre. If local welfare organizations would participate in the planting program, this cost could be reduced materially.

In order to give as definite an idea as possible of the investment needed to start the project and run it for the first ten years, the following table of approximate investment and returns has been prepared:

Initial investment		
Cost of tract		$10,000
Yearly budget (for ten years)		
Salary of ranger	$1,000	
Cost of planting 14 acres at $10 an acre	140	
Express charges on trees at $1 a thousand	20	
Roads, trails, and other improvements (one man for three months at $100 a month)	300	
Incidentals, team hire, tools, etc.	40	
Contingent fund	40	
		$1,540
Yearly income (for ten years)		
180 cords of wood, net $3 a cord		540
Annual expense		$1,000
Total investment for ten-years period		
Cost of tract	$10,000	
Expense for ten years at $1000 a year	10,000	
	$20,000	

The total investment for the first ten years would thus be at least $20,000.

PERMANENT IMPROVEMENT PLAN

The tract is bounded on all sides except the south by good roads, and for the present, therefore no improvement is needed in this direction. The improvements most needed at present are good, safe trails along the gorges. Trails already exist, and by improving these, adding guard rails where needed, the places most visited could be made readily accessible and safe. A small building near the entrance to Buttermilk Falls is also needed as a place where visitors can leave small articles, and this

FIG. 31. LOOKING WEST ACROSS INLET VALLEY FROM THE RIM OF LICK GORGE

could be utilized also as a place for storing tools. Cans for the placing of refuse should be provided around spots that are used by picnickers.

FOREST PROTECTION PLAN

Fire control

The tract does not show signs of any serious fires. Small areas have been burned over from time to time, but no serious fire hazard exists at the present time.

The chief causes of fires on this tract would be from railroads, picnickers, campfires, cigarette and cigar stubs, and lightning. The danger of fire from the railroad can be reduced to a minimum by plowing a strip about 20 feet

wide, about 100 feet from the boundary. The area between the plowed strip and the railroad should be kept cleared by burning over every fall.

The posting of fire notices should eliminate all other fires except those caused by lightning, and the danger from this source is small. The fire notices should be of an educational nature and enlist the cooperation of the public. They should state that it is a community forest, conducted to increase the health and prosperity of the town. Due to the good roads around the tract, the presence of farms on nearly all sides, and the excellent view of the area obtained from the state road, the scheme of protection would be very simple. Cooperation with the people living around the tract and with the public in general would practically solve the problem. The forest ranger, living on the state road, would have the larger part of the area under his eye, and by cooperating with the farmers around the tract he would be able to get, in a very short time, a force of men sufficient to cope with any fire.

The tools that would be needed are plows, shovels, rakes, mattocks, and axes. These should be stored near Buttermilk Falls and at the headquarters of the forest ranger. A bucket pump would be useful around the streams.

Insect control

The only serious insect damage found is that of the white pine weevil. The crooks in the tops of the older pine trees indicate that this insect has been present for at least thirty years. Practically all the white pine reproduction shows the effect of weeviling and indicates that the insect is very abundant at present.

Up to the present time no satisfactory method of control on large areas has been found. Pruning out the infested leaders, and either burning the pruned tops or preserving them in such a way as to kill the weevil and save the parasites, has been tried. This method is expensive and has not proved to be very successful.

Felt (1906) recommends using a net with a diameter of 15 inches, to collect the weevil on white pine leaders. This work should begin in April, as soon as the weather is moderately warm, and should be continued for several weeks at intervals of a week or ten days. Where used, this method has proved fairly successful and the cost reasonable, but more extensive experiments are necessary before the method can be recommended.

Fungus control

The only serious fungous disease on the tract is the chestnut blight (*Endothia parasitica*). No practical method of control has been devised for this disease. As stated under *Silviculture* (page 71), the improvement cuttings will remove the diseased chestnut and thus it will be eliminated from the area.

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APPENDIX

TABLE 1. TREES ON AN AVERAGE ACRE OF OLD FIELD TYPE

(Based on 2.3 acres)

Diameter breast-high (inches)	White pine	Hemlock	White oak	Black oak	Hard maple	Bass-wood	Chest-nut	Ash	Hickory	Beech	Miscel-laneous	Total
6	4.0	2.1	......	......	......	0.9	......	1.7	......	......	5.2	13.9
7	1.3	0.9	......	......	......	......	......	......	......	......	4.0	6.2
8	1.7	3.5	......	......	0.4	0.9	......	1.3	......	......	3.5	11.3
9	1.3	1.3	......	0.4	......	......	......	......	......	......	1.7	4.7
10	......	1.7	......	......	......	......	......	0.4	......	......	1.7	3.8
11	0.4	1.3	......	......	......	......	......	......	......	......	0.9	2.6
12	......	1.3	......	......	......	......	......	......	......	......	0.4	1.7
13	......	......	......	......	......	......	......	......	......	......	0.9	0.9
14	......	0.4	0.4	......	......	......	......	......	......	......	......	0.8
15	0.4	......	......	......	......	......	......	......	......	......	0.4	0.8
16	......	0.4	......	......	......	......	......	......	......	......	......	0.4
17	0.4	......	......	......	......	......	......	......	......	......	......	0.4
Total	9.5	12.9	0.4	0.4	0.4	1.8	......	3.4	......	......	18.7	47.5

TABLE 2. VOLUME ON AN AVERAGE ACRE OF OLD FIELD TYPE
(Based on 2.3 acres)

Diameter breast-high (inches)	Board feet		Cubic feet									Total	
	White pine	Hem-lock	White oak	Black oak	Hard maple	Bass-wood	Chest-nut	Ash	Hick-ory	Beech	Miscel-laneous	Board feet	Cubic feet
6	80	11	......	....	......	1.8	......	10.0	......	......	12.5	91	24.3
7	39	7	......	....	......	......	......	......	......	......	22.4	46	22.4
8	73	42	......	....	3.5	7.7	......	14.3	......	......	29.4	115	54.9
9	74	30	......	5.0	......	......	......	......	......	......	23.6	104	28.6
10	......	58	......	....	......	......	......	7.5	......	......	29.1	58	36.6
11	40	61	......	....	......	......	......	......	......	......	19.4	101	19.4
12	......	101	......	....	......	......	......	......	......	......	10.7	101	10.7
13	......	......	......	....	......	......	......	......	......	......	29.0	......	29.0
14	......	40	14.7	....	......	......	......	......	......	......	......	40	14.7
15	98	......	......	....	......	......	......	......	......	......	18.6	98	18.6
16	......	61	......	....	......	......	......	......	......	......	......	61	......
17	143	......	......	....	......	......	......	......	......	......	......	143	......
Total	547	411	14.7	5.0	3.5	9.5	......	31.8	......	......	194.7	958	259.2

TABLE 5. TREES ON AN AVERAGE ACRE OF SLOPE WOODED TYPE
(Based on 39.8 acres)

6	0.7	3.5	1.5	1.2	1.6	1.5	2.4	1.5	1.0	1.0	5.0	20.9
7	0.7	2.4	1.2	1.8	1.6	2.0	1.6	0.8	0.4	0.9	4.4	17.8
8	0.5	0.9	1.0	1.0	0.8	1.2	2.4	0.6	0.4	0.5	1.6	10.9
9	0.08	0.6	0.7	0.6	0.08	0.9	0.5	0.6	0.6	0.25	2.6	7.51
10	0.16	0.6	0.7	0.5	0.25	0.7	0.3	0.25	0.4	0.25	1.9	6.01
11	0.08	0.5	0.5	0.4	0.25	0.08	0.3	0.25	0.32	0.08	0.25	3.01
12	0.25	0.16	0.7	......	0.16	......	0.4	......	0.16	0.16	0.16	2.15
13	......	0.40	0.08	0.7	0.16	......	0.08	......	0.08	0.08	0.50	2.08
14	0.08	0.25	0.16	0.16	0.08	......	0.08	0.08	0.50	......	0.08	1.47
15	0.08	0.08	0.16	0.50	......	......	0.25	0.08	0.16	......	0.08	1.39
16	......	0.25	0.16	0.32	......	......	0.08	......	......	......	0.16	0.97
17	......	0.16	0.08	0.08	......	......	......	......	0.16	......	......	0.48
18	......	0.08	0.08	......	......	......	......	0.08	......	......	0.08	0.32
19	......	......	......	0.08	......	......	0.08	......	......	......	......	0.16
20	......	0.16	......	0.16	......	......	......	......	0.08	......	......	0.40
21	......	0.16	0.08	......	......	......	......	......	......	......	......	0.24
22	......	......	......	......	......	......	......	......	......	......	......	......
23	......	......	......	0.08	......	......	......	......	......	......	......	0.08
24	......	......	0.08	......	......	......	......	0.08	......	......	......	0.16
25	......	......	......	......	......	......	......	......	......	......	......	......
26	......	......	......	......	......	......	......	......	......	......	......	......
27	......	......	0.08	......	......	......	......	......	......	......	......	0.08
Total	2.63	10.20	7.26	7.58	4.98	6.38	8.47	4.32	4.26	3.22	16.81	76.11

TABLE 4. VOLUME ON AN AVERAGE ACRE OF SLOPE CUT OVER TYPE
(Based on 12.3 acres)

Diameter breast-high (inches)	Board feet		Cubic feet									Total	
	White pine	Hem-lock	White oak	Black oak	Hard maple	Bass-wood	Chest-nut	Ash	Hick-ory	Beech	Miscel-laneous	Board feet	Cubic feet
6	14	18	6.5	5.8	3.8	3.0	9.4	8.9	3.9	2.5	12.0	32	55.8
7	21	19	7.6	12.1	8.8	10.0	9.1	6.6	2.5	5.5	24.6	40	86.8
8	22	11	9.0	9.3	7.0	10.3	19.0	6.6	3.8	5.2	13.4	33	83.6
9	5	14	9.1	7.6	1.0	11.1	5.3	8.6	7.6	3.6	36.1	19	90.0
10	12	20	11.8	8.1	4.0	11.5	4.1	4.7	6.7	4.7	32.5	32	88.1
11	8	24	10.6	8.2	5.0	1.7	5.3	5.8	7.0	1.9	5.4	32	50.9
12	32	10	18.2	....	3.9	......	8.9	......	4.4	4.4	4.3	42	44.1
13	......	31	2.5	21.7	4.7	......	2.1	......	2.7	2.7	16.1	31	52.5
14	16	25	5.9	5.9	2.8	......	2.6	3.2	20.4	......	3.1	41	43.9
15	20	10	7.0	22.0	......	......	9.2	3.8	7.6	......	3.7	30	53.3
16	......	38	8.2	16.4	......	......	3.5	......	......	......	8.9	38	37.0
17	......	29	4.7	4.7	......	......	......	......	10.4	......	......	29	19.8
18	......	17	5.2	....	......	......	......	5.7	......	......	6.0	17	16.9
19	......	......	......	5.9	......	......	5.2	......	......	......	......	......	11.1
20	......	48	......	12.9	......	......	......	......	7.4	......	......	48	20.3
21	......	56	7.1	....	......	......	......	......	......	......	......	56	7.1
22	......	......	......	....	......	......	......	......	......	......	......	......	......
23	......	......	......	8.2	......	......	......	......	......	......	......	......	8.2
24	......	......	8.9	....	......	......	......	10.4	......	......	......	......	19.3
25	......	......	......	....	......	......	......	......	......	......	......	......	......
26	......	......	......	....	......	......	......	......	......	......	......	......	......
27	......	......	10.2	....	......	......	......	......	......	......	......	......	10.2
Total	150	370	132.5	148.8	41.0	47.6	83.7	64.3	84.4	30.5	166.1	520	798.9

TABLE 5. TREES ON AN AVERAGE ACRE OF SLOPE WOODED TYPE
(Based on 39.8 acres)

Diameter breast-high (inches)	White pine	Hemlock	White oak	Black oak	Hard maple	Bass-wood	Chest-nut	Ash	Hickory	Beech	Miscel-laneous	Total
6	1.3	4.3	1.7	2.5	2.9	3.1	1.4	1.5	1.7	1.6	5.5	27.5
7	1.1	2.9	1.4	1.7	1.9	2.0	0.8	0.7	1.7	1.1	3.9	19.2
8	0.8	3.1	0.8	1.3	1.5	1.6	0.5	0.5	1.3	1.1	3.5	16.0
9	0.6	2.3	0.7	1.0	0.6	1.0	0.3	0.4	1.5	0.6	1.7	10.7
10	0.5	1.6	0.7	1.0	0.5	0.8	0.4	0.3	1.3	0.6	1.4	9.1
11	0.4	1.3	0.6	0.7	0.35	0.7	0.23	0.2	0.9	0.4	1.0	6.78
12	0.3	0.8	0.6	0.7	0.15	0.5	0.15	0.2	0.7	0.4	0.6	5.10
13	0.18	0.4	0.4	0.5	0.10	0.2	0.23	......	0.5	0.08	0.5	3.09
14	0.15	0.3	0.5	0.3	0.03	0.3	0.15	0.05	0.33	0.10	0.5	2.71
15	0.13	0.3	0.3	0.2	0.03	0.18	0.18	0.08	0.15	......	0.28	1.83
16	0.08	0.05	0.05	0.2	0.03	0.08	0.03	0.03	0.03	0.03	0.28	0.89
17	0.15	0.13	0.10	0.18	0.03	0.03	0.13	0.03	0.05	......	0.05	0.88
18	0.05	0.05	0.13	0.03	0.03	0.08	0.05	......	0.03	0.03	......	0.48
19	0.08	0.05	0.03	0.03	0.03	0.05	0.05	......	......	......	......	0.32
20	0.08	0.03	0.15	0.05	......	0.08	0.03	0.03	0.03	0.05	0.03	0.56
21	......	......	0.10	......	0.03	......	0.03	......	......	......	......	0.16
22	0.05	0.03	......	0.05	......	......	......	......	......	......	......	0.13
23	......	......	0.05	......	......	......	0.03	......	0.03	......	0.05	0.16
24	......	0.03	......	......	0.03	......	......	......	......	......	......	0.06
25	......	0.03	......	0.03	......	0.03	......	......	......	......	......	0.09
26	......	......	......	......	......	......	......	......	......	......	......	......
27	......	0.05	......	......	......	......	......	......	......	......	......	0.05
Total	5.95	17.75	8.31	10.47	8.24	10.73	4.69	4.02	10.25	6.09	19.29	105.79

TABLE 6. VOLUME ON AN AVERAGE ACRE OF SLOPE WOODED TYPE
(Based on 39.8 acres)

Diameter breast-high (inches)	Board feet		Cubic feet									Total	
	White pine	Hemlock	White oak	Black oak	Hard maple	Basswood	Chestnut	Ash	Hickory	Beech	Miscellaneous	Board feet	Cubic feet
6	27	22	7.3	12.0	7.0	6.2	5.5	8.9	6.6	4.0	13.2	49	70.7
7	33	22	8.8	11.4	10.5	10.0	4.6	5.7	10.5	6.7	21.8	55	90.0
8	34	37	7.2	12.1	13.2	13.8	4.0	5.5	12.0	11.4	29.4	71	108.6
9	34	53	9.1	12.6	7.4	12.3	3.2	5.8	18.9	8.5	23.6	87	101.4
10	38	54	11.7	16.2	8.0	13.1	5.5	5.6	21.8	11.2	23.9	92	117.0
11	40	61	12.8	14.4	7.0	14.8	4.0	4.7	19.7	9.4	21.5	101	108.3
12	38	49	15.6	17.9	3.7	13.3	3.3	5.6	19.2	10.9	16.1	87	105.6
13	30	31	12.4	15.5	3.0	6.6	6.2	......	16.8	2.7	16.1	61	79.3
14	30	50	18.4	11.1	1.1	12.0	4.8	2.0	13.6	4.0	19.6	80	86.6
15	32	36	13.1	8.8	1.2	8.8	6.8	3.8	7.2	......	13.0	68	62.7
16	24	8	2.6	10.2	1.4	4.6	1.3	1.7	1.7	1.6	15.5	32	40.6
17	54	23	5.9	10.6	1.7	2.0	6.6	1.9	3.2	......	3.2	77	35.1
18	21	11	8.7	1.9	1.9	6.1	2.9	......	2.3	2.3	......	32	26.1
19	40	13	2.1	2.2	2.2	4.3	3.2	......	......	......	......	53	14.0
20	45	9	12.2	4.0	......	7.8	2.2	2.6	2.8	......	2.9	54	34.5
21	......	......	8.8	....	2.9	......	2.5	......	......	4.7	......	......	18.9
22	37	12	......	4.7	......	......	......	......	......	......	......	49	4.7
23	......	......	5.2	....	......	......	3.0	......	3.7	......	6.9	......	18.8
24	......	16	......	....	4.1	......	......	......	......	......	......	16	4.1
25	......	17	......	3.5	......	4.8	......	......	......	......	......	17	8.3
26	......	......	......	....	......	......	......	......	......	......	......	......	......
27	......	36	......	....	......	......	......	......	......	......	......	36	......
Total	557	560	161.9	169.1	76.3	140.5	69.6	53.8	160.0	77.4	226.7	1,117	1,135.3

TABLE 7. SUMMARY OF ESTIMATES OF VOLUME ON ALL TYPES

(Representing the stand on 212.8 acres of the old field type, on 46.9 acres of the slope cut over type, and on 482.5 acres of the slope wooded type, a total of 742.2 acres. Based on tables 2, 4, and 6)

Type	Softwoods (board feet)	Hardwoods (cubic feet)
Old field	203,862	55,158
Slope cut over	24,388	37,468
Slope wooded	538,953	546,817
Total	767,203	639,443

639,443 cubic feet = 7105 cords (based on 90 cubic feet of solid wood per cord)

TABLE 8. VOLUME AND HEIGHT DATA FOR THE CUCUMBER TREE

(Volumes based on table 36, U. S. Dept. Agr. Bulletin 285. Heights read from curve based on 22 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (cubic feet)
6	54	2.6
7	58	5.8
8	62	9.5
9	65	13.7
10	67	17.9
11	70	22.8
12	72	28.8
13	74	34.9
14	75	41.3
15	77	49.7
16	78	57.2
17	79	65.3
18	80	74.0
19	80	82.9
20	81	92.7

TABLE 9. VOLUME AND HEIGHT DATA FOR BASSWOOD

(Volumes based on table 36, U. S. Dept. Agr. Bulletin 285. Heights read from curve based on 47 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (cubic feet)
6	50	2.0
7	53	5.0
8	56	8.6
9	58	12.3
10	61	16.4
11	64	21.1
12	66	26.6
13	69	33.2
14	72	40.1
15	75	48.7
16	78	57.2
17	81	66.0
18	84	76.0
19	86	86.5
20	88	96.9
21	90	107.6
22	92	120.0
23	94	132.8
24	95	145.5
25	96	158.8
26	97	171.6
27	98	186.2
28	99	202.1

TABLE 10. VOLUME AND HEIGHT DATA FOR HICKORY

(Volumes based on tables 7 and 8, U. S. Forest Service Bulletin 80. Heights read from curve based on 55 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (cubic feet)
6	45	3.9
7	50	6.2
8	55	9.2
9	59	12.6
10	63	16.8
11	67	21.9
12	70	27.4
13	73	33.6
14	76	40.7
15	78	47.8
16	81	56.2
17	83	64.9
18	86	75.2
19	89	84.3
20	91	93.1
21	93	102.8
22	95	113.2
23	97	124.8

TABLE 11. VOLUME AND HEIGHT DATA FOR HEMLOCK

(Volumes based on table 12, U. S. Dept. Agr. Bulletin 152. Heights read from curve based on 52 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (board feet)
6	43	5
7	46	8
8	48	12
9	51	23
10	53	34
11	55	47
12	57	61
13	60	78
14	63	100
15	65	120
16	68	152
17	70	180
18	73	219
19	75	260
20	77	301
21	80	350
22	82	398
23	84	456
24	86	520
25	88	586
26	90	660
27	92	734
28	94	816
29	96	904
30	98	1,008

TABLE 12. VOLUME AND HEIGHT DATA FOR RED OAK AND BLACK OAK

(Volumes based on table 39, U. S. Forest Servic Bulletin 96. Heights read from curve based on 71 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (cubic feet)
6	48	4.8
7	51	6.7
8	55	9.3
9	58	12.6
10	62	16 2
11	65	20.6
12	68	25.5
13	70	31.0
14	72	37.0
15	75	43.9
16	77	51.1
17	79	58.7
18	81	64.7
19	82	73.7
20	83	80.8
21	84	87.8
22	85	94.9

TABLE 13. VOLUME AND HEIGHT DATA FOR WHITE OAK AND CHESTNUT OAK

(Volumes based on table 40, U. S. Forest Service Bulletin 96. Heights read from curve based on 112 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (cubic feet)
6	41	4.3
7	47	6.3
8	53	9.0
9	58	13.0
10	61	16.8
11	64	21.3
12	67	26.0
13	69	31.0
14	71	36.8
15	73	43.6
16	75	51.3
17	77	58.9
18	78	67.0
19	79	73.7
20	80	81.5
21	81	88.3
22	82	96.1
23	83	104.1
24	83	111.7

TABLE 14. VOLUME AND HEIGHT DATA FOR WHITE PINE

(Volumes based on table 24, U. S. Dept. Agr. Bulletin 13. Heights read from curve based on 58 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (board feet)
6	41	20
7	44	30
8	48	43
9	51	57
10	54	76
11	58	99
12	61	128
13	65	164
14	68	203
15	71	245
16	75	300
17	78	357
18	82	424
19	85	495
20	88	568
21	92	651
22	95	730
23	98	813
24	101	904
25	104	1,007
26	107	1,124
27	109	1,234
28	111	1,346

TABLE 15. VOLUME AND HEIGHT DATA FOR CHESTNUT

(Volumes based on table 38, U. S. Forest Service Bulletin 96. Heights read from curve based on 41 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (cubic feet)
6	42	3.9
7	46	5.7
8	50	7.9
9	53	10.6
10	56	13.7
11	59	17.6
12	62	22.2
13	64	26.8
14	66	32.0
15	68	37.8
16	70	44.0
17	72	50.8
18	73	57.8
19	74	64.9
20	75	73.3
21	76	81.8
22	77	91.4
23	77	100.1
24	78	111.1
25	78	120.9
26	78	132.3
27	78	145.0
28	78	159.1

TABLE 16. VOLUME AND HEIGHT DATA FOR ASH

(Volumes based on table 32, U. S. Dept. Agr. Bulletin 299. Heights read from curve based on 51 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (cubic feet)
6	53	5.9
7	56	8.2
8	59	11.0
9	62	14.4
10	65	18.8
11	68	23.3
12	70	28.2
13	73	34.2
14	75	40.3
15	77	46.9
16	79	55.0
17	80	62.7
18	82	71.2
19	83	79.1
20	84	87.8
21	85	97.6
22	86	106.9
23	87	117.5
24	88	130.0

TABLE 17. VOLUME AND HEIGHT DATA FOR BEECH

(Volumes based on tables 32 and 33, U. S. Dept. Agr. Bulletin 285. Heights read from curve based on 31 trees)

Diameter breast-high (inches)	Total height (feet)	Volume (cubic feet)
6	46	2.5
7	53	6.1
8	58	10.4
9	62	14.2
10	66	18.7
11	68	23.4
12	71	27.2
13	73	33.4
14	75	39.9
15	77	46.6

TABLE 18. VOLUME AND HEIGHT DATA FOR HARD MAPLE

(Volumes based on table 35, U. S. Dept. Agr. Bulletin 285. Heights read from curve based on 50 trees)

Diameter breast-high (inches)	Total height (feet)	Volume* (cubic feet)
6	52	2.4
7	54	5.5
8	56	8.8
9	58	12.3
10	60	15.9
11	62	20.0
12	64	24.5
13	66	29.6
14	68	35.2
15	70	41.2
16	71	47.6
17	73	55.6
18	75	64.0
19	77	73.7
20	79	84.1
21	81	95.9
22	83	107.4
23	85	121.1
24	87	136.4
25	89	152.9
26	91	171.2

* The volume as given includes both logs and top. All volumes given in this table have been reduced 5 per cent to make them more nearly represent the volumes of hard maple in this locality.

ME AND HEIGHT DATA FOR THE TULIP TREE

. S. Dept. Agr. Bulletin 285. Heights read from curve

st-high)	Total height (feet)	Volume (cubic feet)
....	59	2.0
....	62	6.2
....	64	9.2
....	66	13.9
....	68	18.2
....	70	23.0
....	72	28.8
....	74	34.9
....	76	41.7
....	78	50.2
....	80	58.2
....	82	66.5
....	84	76.0
....	86	86.5
....	87	96.3
....	88	106.4
....	90	118.6
....	92	131.4
....	94	144.8
....	95	158.0
....	96	170.8
....	97	185.3
....	97	200.3

) HEIGHT DATA FOR MISCELLANEOUS SPECIES[4]

S. Dept. Agr. Bulletin 285. Heights read from curve

st-high	Total height (feet)	Volume (cubic feet)
....	50	2.4
....	53	5.6
....	56	8.4
....	59	13.9
....	62	17.1
....	64	21.5
....	67	26.8
....	70	32.2
....	73	39.2
....	75	46.4
....	78	55.5
....	80	64.0
....	83	75.3
....	85	86.4
....	87	98.0
....	89	111.2
....	90	124.8
....	91	138.8

cherry, ironwood, soft maple, cedar, red pine, and pitch pine

TABLE 21. GROWTH OF WHITE PINE IN DIAMETER

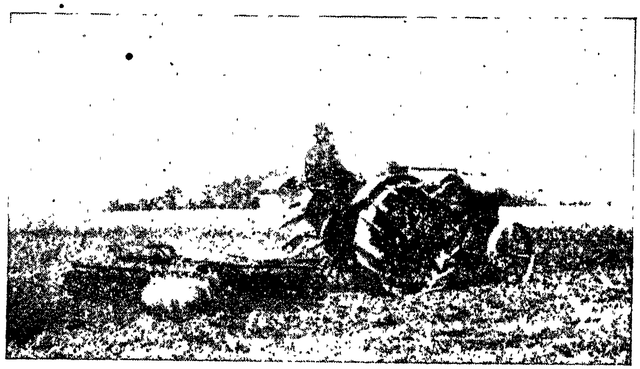
(From data obtained by G. E. Bentley and B. H. Paul in 1912, at Enfield Falls, New York)

Age of trees (years)	Diameter breast-high (inches)
5	0.924
10	2.18
15	3.63
20	5.15
25	6.48
30	7.86
40	10.05
50	12.50
60	14.16
70	16.35
80	17.80
90	23.12
100	23.90

July, 1921 Bulletin 405

An Economic Study of Farm Tractors in New York

W. I. Myers



CONTENTS

AN ECONOMIC STUDY OF FARM TRACTORS IN NEW YORK

W. I. Myers

Within recent years the number of farm tractors on New York farms has been increasing rapidly. According to the census of New York agriculture taken on February 1, 1918, there were at that time 2982 farm tractors in the State. The distribution of these tractors by

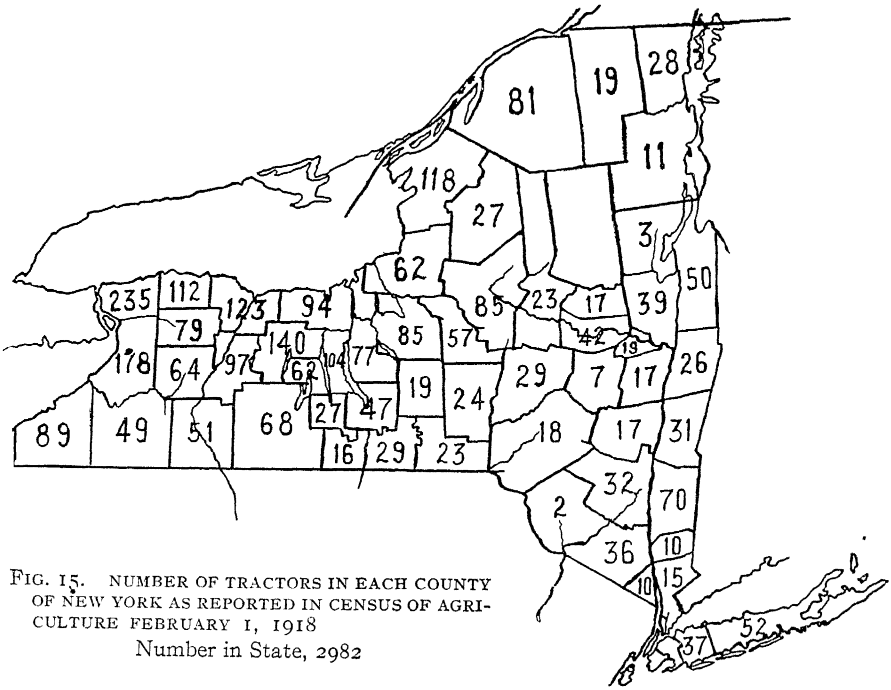


FIG. 15. NUMBER OF TRACTORS IN EACH COUNTY OF NEW YORK AS REPORTED IN CENSUS OF AGRICULTURE FEBRUARY 1, 1918
Number in State, 2982

counties and their proportion to the number of farms are shown in figures 15 and 16. Although they are rather widely scattered over the State, a large proportion of the tractors are in the comparatively level farming region of western New York. Nearly one-half of the entire number reported in the census were in the fourteen counties north and west of Ithaca. The proportion of tractors to farms was also highest in western New York. Niagara County, with the largest number of tractors, had one tractor to every 17 farms at the time when the census was taken. Although more recent figures are not available,

it is a matter of common observation that the number of farm tractors has increased rapidly since 1918.

Probably the most important single reason for the great increase in the use of tractors has been the shortage of farm labor within recent years. Other factors, such as the increased cost of keeping horses, and the mechanical improvements in tractors, have also contributed to this result. Farmers in every community, whether or not they own tractors, are interested and are watching carefully the performance of the different

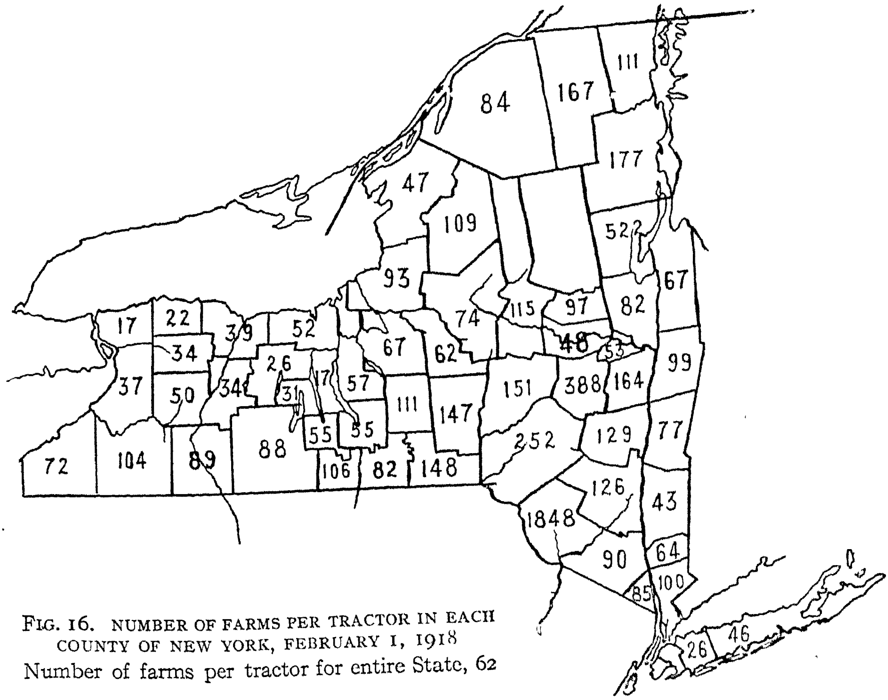


FIG. 16. NUMBER OF FARMS PER TRACTOR IN EACH COUNTY OF NEW YORK, FEBRUARY 1, 1918
Number of farms per tractor for entire State, 62

machines in their neighborhood. The tractor demonstrations that have been held in different parts of the State have been useful in showing what a tractor can do under favorable conditions and with an expert operator, but they have not given much of an idea of what may reasonably be expected under ordinary farm conditions. As a result of the widespread interest in tractors, there has arisen a demand for information in regard to the costs of tractor operation and the economic effects of the machines on farming. It is yet too soon to answer these questions fully. The small farm tractor, drawing two or three plows, is a comparatively new machine. As yet there is a lack of standardization of types, and important changes are being made in most models nearly every year. The rapid

increase in the use of tractors in recent years has taken place in a period when economic conditions on farms were far from normal. Most of the tractor owners of today have not owned tractors long enough to determine fully their effects on farm organization and operation. The object of the study herein described was to get as much information as possible at the present time from farmers who have had experience with tractors, for the use of all interested persons.

METHODS OF STUDY

Detailed records were obtained by going to farms in the general farming region in the southwestern part of Cayuga County and in the fruit region of northern Monroe and Orleans Counties, during May and June, 1920. Detailed answers concerning his tractor costs and other factors were obtained from each farmer visited. Records were obtained only from farmers who had owned tractors for at least one year. The data on costs and other factors were for the year ending March 1, 1920.

In addition to these records, questionnaires were sent by mail to tractor owners in most of the counties of the State in order to obtain additional information from a large number in regard to their tractor experience. No attempt was made to get data on costs by these questionnaires, but much information was obtained on the amount and kind of work done by tractors and on the effects of tractors on farming. Names and addresses of tractor owners were obtained through the cooperation of the county agents. Lists of owners were thus made available, and questionnaires were sent to tractor owners in all of the agricultural counties of the State except Niagara, Genesee, Tompkins, Chenango, Hamilton, Putnam, and Nassau.

DESCRIPTION OF THE REGIONS STUDIED

CAYUGA COUNTY, A GENERAL FARMING REGION

About fifty records were obtained by personal visits to farmers in the general farming region in the southwestern part of Cayuga County. Forty-six of these records were used in these studies, four being discarded because of unusual conditions. Two records were for tractors of an old model which had been found too heavy for economical field work. One of these was a six-plow tractor used principally for belt power. The other was used for only three hours, in the year 1919. Another record was for a tractor used largely for custom threshing, its owner being primarily a thresherman. The fourth was discarded because the tractor was sold before 1919, the record obtained being for the previous year.

The farms visited are located in the townships of Aurelius, Springport, Ledyard, Venice, Genoa, Scipio, and Fleming. This region is typical of much of the general farming region of western New York. The topog-

raphy, in general, is level or gently rolling, and few steep slopes are found. More than three-fifths of the crop land of the farms visited was classed by the writer as approximately level. The elevation increases gradually from about 500 feet near Auburn to a maximum of 1400 feet on the rolling plateau east of Salmon Creek, near Venice. The sides of the valleys cut into this plateau by Salmon and Little Salmon Creeks are rather steep, but few tractors were found under these conditions. The average elevation of the farms visited in this region was 893 feet.

The soils of the farms visited are medium to heavy in texture. The most important soil type was classed as Miami stony loam in the soil survey of this region made in 1904. This soil will probably be subdivided into various phases of the Ontario series — Ontario loam, silt loam, and gravelly silt loam — in the resurvey of 1920. It comprises about one-half of the total area of the farms visited. The soils classified in 1904 as Dunkirk loam and Dunkirk clay loam each constitute about one-fourth of the total area of these farms. In the soil survey of 1920 this classification has been changed and the soils have been subdivided into a number of new soil types.

The type of farming in this region is uniform, the principal crops being hay, wheat, buckwheat, barley, oats, and corn. Fruit is not important and few potatoes are grown for market. Cows are the most important stock kept, but as there is little untillable pasture the dairies are usually small. The average value of the farms visited in this region, as estimated by the farmers, was $91 an acre. The average area per farm of the important crops both before and after the purchase of a tractor are shown in table 1:

TABLE 1. KIND AND AREA OF CROPS GROWN ON 46 FARMS IN CAYUGA COUNTY, NEW YORK—A GENERAL FARMING REGION

	Acres per farm		Per cent of crop area	
	Year before purchase of tractor	In 1919 after purchase of tractor	Year before purchase of tractor	In 1919 after purchase of tractor
Hay	61.3	63.8	43.5	41.5
Oats and barley	29.2	32.4	20.7	21.1
Wheat	23.4	27.4	16.6	17.8
Buckwheat	13.0	15.5	9.2	10.1
Corn for grain	6.6	6.2	4.7	4.0
Corn for silage	5.6	5.6	4.0	3.6
Potatoes	0.5	0.6	0.4	0.4
Rye	0.5	1.0	0.4	0.6
Other crops	0.7	1.4	0.5	0.9
Total crops	140.8	153.9	100.0	100.0
Total farm area	199.7	216.5	....	....

About two-fifths of the crop area of these farms was in hay, one-fifth in oats and barley, one-sixth in wheat, and most of the remainder in buckwheat and corn. More than 98 per cent of the entire crop area was in these five crops. Nearly every farmer has a small orchard, but these orchards are not cultivated and their area was therefore omitted.

MONROE AND ORLEANS COUNTIES, A FRUIT REGION

Forty-two records were obtained from farms in the northern part of Monroe and Orleans Counties, adjoining Lake Ontario. Of these records, forty-one were used in these studies, the other being discarded because of incomplete data.

All of the farms visited in this region are located between the Ridge Road and Lake Ontario, and more than three-fourths of them are north of the Niagara Falls branch of the New York Central Railroad. They are located in the townships of Hamlin, Parma, and Greece, in Monroe County, and Carlton and Kendall, in Orleans County. The topography of this region is, in general, level or gently rolling. More than two-thirds of the crop land in these farms was classed by the writer as approximately level. The elevation of the region increases gradually from the lake southward, varying from 264 feet, the level of the lake, to about 430 feet on the Ridge Road. The highest elevation of any of the farms visited was 360 feet and the average elevation of all farms visited was 290 feet.

The soils of the farms visited range in texture from light sandy loams to medium heavy loams, about one-third being classed as light and two-thirds as medium. The soil classed in the soil survey of Monroe County as Dunkirk silt loam is the most important soil type, comprising slightly more than one-half of the area of the farms studied, while Ontario loam and Dunkirk fine sandy loam constitute most of the remainder.

This area is in the heart of the most important fruit-growing region of the State. Fruit is the most important crop. Wheat, hay, oats, barley, and corn also are grown, together with smaller acreages of beans, cabbage, potatoes, rye, and buckwheat. Because of the small area of untillable land and the high value of the cultivated land for fruit production, but little stock is kept in this region. Many farmers do not raise enough feed for the horses kept, and depend partly on purchased hay and grain. The average value of the farms visited in this region was $201 an acre. The area and relative importance of the various crops grown, both before and after the purchase of a tractor, are shown in table 2.

More than one-half of the crop land of these farms is devoted to fruit, and nearly four-fifths of the fruit area is now bearing. Most of the young orchards are intercropped, the average area of land double-cropped being about eight acres per farm. Apples, peaches, and pears are the most

important fruit crops, but small acreages of cherries, plums, prunes, and quinces also are grown. The relative importance of apples and peaches varies widely in different localities, peaches being grown principally on the lighter soils. Beans were formerly an important cash crop, but after several unfavorable years they have almost disappeared. Potatoes are grown only for home use on most farms.

TABLE 2. KIND AND AREA OF CROPS GROWN ON 41 FARMS IN MONROE AND ORLEANS COUNTIES — A FRUIT REGION

	Acres per farm		Per cent of land devoted to crops	
	Year before purchase of tractor	In 1919 after purchase of tractor	Year before purchase of tractor	In 1919 after purchase of tractor
Fruit, bearing:				
Apples	19.5	21.4	18.7	19.3
Peaches	14.5	14.9	13.9	13.4
Pears	5.3	5.3	5.1	4.8
Cherries	1.2	1.4	1.2	1.3
Other fruit	1.6	1.6	1.5	1.4
Total bearing fruit	42.1	44.6	40.4	40.2
Fruit, not bearing:				
Apples	10.9	11.4	10.5	10.3
Peaches	1.5	1.6	1.4	1.4
Other fruit	0.6	0.8	0.6	0.7
Total fruit not bearing	13.0	13.8	12.5	12.4
Total fruit	55.1	58.4	52.9	52.6
Crops other than fruit:				
Hay	17.1	18.1	16.4	16.3
Wheat	16.8	20.5	16.1	18.5
Oats and barley	10.1	7.9	9.7	7.1
Corn for grain	3.8	3.8	3.6	3.4
Corn for silage or fodder	3.3	3.6	3.2	3.2
Potatoes	1.9	1.9	1.8	1.7
Beans	1.1	0.8	1.1	0.7
Buckwheat	1.1	1.1	1.1	1.0
Cabbage	0.9	1.2	0.9	1.1
Rye	0.9	1.0	0.9	0.9
Other crops	0.1	1.1	0.1	1.0
Total crops other than fruit	57.1	61.0	54.8	55.0
Total crops	112.2	119.4	107.7	107.6
Land double-cropped	8.0	8.4	7.7	7.6
Land devoted to crops	104.2	111.0	100.0	100.0
Total farm area	135.8	147.7	....	....

OTHER REGIONS FOR WHICH DATA WERE OBTAINED

In addition to the detailed records on costs and effects of tractor operation obtained from Cayuga, Monroe, and Orleans Counties, questionnaires were sent by mail to all tractor owners in the State whose names and addresses could be learned. No attempt was made to get costs, but an attempt was made to get as much information as possible regarding the kind of tractor owned, the crops grown before and after the purchase of a tractor, the work done by the tractor and by horses, and other general

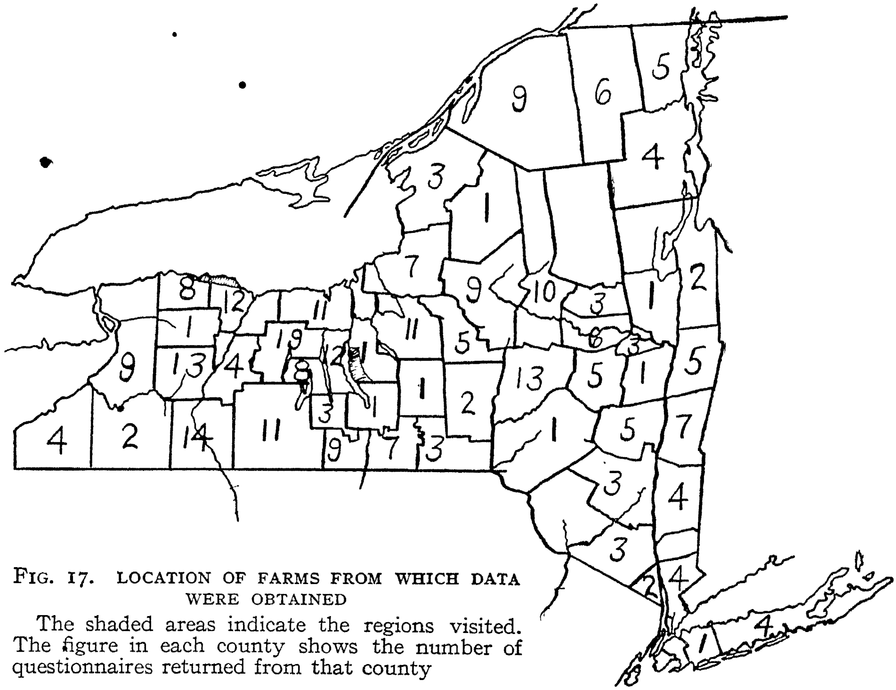


FIG. 17. LOCATION OF FARMS FROM WHICH DATA WERE OBTAINED
The shaded areas indicate the regions visited. The figure in each county shows the number of questionnaires returned from that county

information in regard to each man's experience and satisfaction with tractors. To these questionnaires 428 replies were received, of which 133 were completely filled out, 177 were partly filled out but were usable in part, and 118 were discarded because the owner had not had his tractor for a year or for other reasons. The locations of the farms from which usable data were received are shown in figure 17.

The farms from which replies were received represent most of the important agricultural regions and farming types of the State. The average acreage and kind of each of the important crops grown on the 125 farms for which this information was given are shown in table 3.

TABLE 3. KIND AND AREA OF CROPS GROWN ON 125 NEW YORK FARMS IN VARIOUS COUNTIES

	Number reporting	Acres per farm		Per cent of total land in crops	
		Year before purchase of tractor	In 1919 after purchase of tractor	Year before purchase of tractor	In 1919 after purchase of tractor
Hay	124	44.4	45.1	45.7	40.9
Oats and barley	120	15.4	17.4	15.8	15.8
Corn for silage	85	8.5	10.1	8.7	9.1
Orchard	77	8.5	8.7	8.7	7.9
Wheat	86	8.3	13.8	8.5	12.5
Potatoes	103	3.1	3.6	3.2	3.3
Corn for grain	69	2.8	3.7	2.9	3.4
Beans	25	2.8	2.5	2.9	2.3
Buckwheat	30	1.5	2.8	1.5	2.5
Rye	7	0.5	0.6	0.5	0.5
Other crops	....	1.4	2.1	1.4	1.9
Total land in crops	125	97.2	110.4	100.0	100.0

The most important crop on these farms is hay, which constitutes about two-fifths of the crop area. The other important crops are oats, barley, corn for silage, fruit, wheat, potatoes, corn for grain, beans, and buckwheat. The total crop area of these farms averaged 97.2 acres per farm the year before purchasing a tractor, and 110.4 acres per farm in 1919 after purchasing a tractor. This is more than twice the average crop area per farm (47.6 acres) of all New York farms reporting in the state census of agriculture for 1918.

The makes and sizes of tractors used on 397 New York farms in 1919 are shown in table 4. These farms include 310 farms from which answers to questionnaires were received, as well as the 87 farms visited in Cayuga, Monroe, and Orleans Counties.

TABLE 4. MAKES AND SIZES OF TRACTORS USED ON 397 NEW YORK FARMS IN 1919

Make of tractor	Rated horse-power	Number of each make of tractor	Per cent of total number of all tractors
Fordson	....	88	21.8
International four-cylinder	8–16	59	14.6
International " Titan "	10–20	34	8.4
International " Titan "	12–25	6	1.5
International " Mogul "	8–16	49	12.2
Case	9–18	60	14.9
Case	15–27	7	1.7
Case	12–25	1	0.2
Moline	9–18	16	4.0
Moline	6–12	8	2.0

TABLE 4 (*concluded*)

Make of tractor	Rated horse-power	Number of each make of tractor	Per cent of total number of all tractors
Avery	8–16	14	3.5
Avery	12–25	3	0.7
Avery	5–10	5	1.2
Cleveland	12–20	14	3.5
Waterloo Boy	12–25	9	2.2
Chase	–40	4	1.0
Chase	8–16	2	0.5
Bull	10–20	3	0.7
Bull	7–14	2	0.5
Emerson-Brantingham	12–20	4	1.0
Bates Steel Mule	15–22	3	0.7
Happy Farmer	12–25	3	0.7
Huber	12–25	2	0.5
Automobile attachments	....	2	0.5
Bullock Creeping Grip	....	1	0.2
Gasport Orchard	12–25	1	0.2
Heider	9–16	1	0.2
Light All Work	13–28	1	0.2
Maxim	12–24	1	0.2
Total, all makes	....	403	100.0

COSTS OF TRACTOR OPERATION

The makes and sizes of tractors found on farms in the two regions visited are shown in table 5. Costs of operation were obtained only for these

TABLE 5. Makes and Sizes of Tractors for Which Costs Were Obtained, Used During the Year 1919 by 87 Farmers in Cayuga, Monroe, and Orleans Counties

Make of tractor	Rated horse-power	Number of tractors	Average number of plows used	Average width of plows used (inches)
Fordson	....	21	2.0	13.7
International "Mogul"	8–16	19	2.0	13.8
International "Titan"	10–20	11	2.8	13.4
International four-cylinder	8–16	11	2.0	13.8
Case	9–18	15	2.0	13.8
Case	15–27	2	3.0	14.0
Case	12–25	1	3.0	14.0
Bull	10–20	3	1.7	14.0
Cleveland	12–20	2	2.0	14.0
Chase	–40	2	3.0	14.0
Moline	9–18	2	2.0	14.0
Waterloo Boy	12–25	2	2.8	14.0
Emerson-Brantingham	12–20	1	3.0	14.0
Heider	9–16	1	2.0	14.0
Huber	12–25	1	2.0	14.0
Total	....	94	....	....

tractors. Several farmers exchanged tractors during the year, so that a total of ninety-four different machines were used on the eighty-seven farms. Not more than one tractor at a time was used on any of these farms. Fifteen different makes are represented in the ninety-four different tractors used on these farms during 1919, but more than four-fifths of the entire number were manufactured by three tractor companies. Three of the earlier makes of tractors given in this table are no longer on the market. The rapid improvements in tractor design and construction have resulted in the abandonment of some types of tractors, as well as radical changes in most of the other makes which have been on the market for four years or more. Further improvements may be expected, and it is probable that some of the makes and models of tractors now on the market will likewise have been discarded five years hence.

The amount and value of the various items of cost of tractor operation are shown in table 6. The average annual cost of operating a tractor on these farms was $660, or $1.55 per hour of tractor work. The largest single item of cost was depreciation, $187.25 per tractor, followed in order by tractor operator, fuel, repairs, interest, labor, lubricants, use of buildings, automobile use, insurance, and horse labor. The average cost of a tractor without the operator was $493.37 for the year, or $1.16 per tractor hour.

TABLE 6. COSTS OF TRACTOR OPERATION ON 87 FARMS IN CAYUGA, MONROE, AND ORLEANS COUNTIES, 1919

	Per tractor		Per hour		Per cent of total cost
	Quantity	Value	Quantity	Value	
All work:					
Costs other than fuel and operator:					
Depreciation	....	$187.25	....	$0.441	28.4
Repairs, new parts, and expert labor	....	44.25	....	0.104	6.7
Interest	....	39.72	....	0.093	6.0
Work on tractor by farm labor (hours)	75.3	38.94	0.18	0.092	5.9
Lubrication:					
Oil (gallons)	60.0	34.51	0.14	0.081	5.2
Grease (pounds)	19.5	3.07	0.05	0.007	0.5
Total value of lubricants	....	37.58	....	0.088	5.7
Use of buildings	....	4.82	....	0.011	0.7
Automobile use (miles)	27.8	2.78	....	0.007	0.5
Insurance	....	0.35	....	0.001	0.1
Horse labor (hours)	1.2	0.30	....	0.001	....
Total costs other than fuel and operator	....	$355.99	....	$0.838	53.9

TABLE 6 (*concluded*)

	Per tractor		Per hour		Per cent of total cost
	Quantity	Value	Quantity	Value	
Fuel:					
Kerosene (gallons)	618.7	$97.35	1.46	$0.229	14.8
Gasoline (gallons)	159.1	40.03	0.37	0.094	6.1
Total fuel (gallons)	777.8	$137.38	1.83	$0.323	20.8
Cost of tractor without operator	....	$493.37	....	$1.161	74.8
Tractor operator (hours)	333.3	$166.63	0.78	$0.392	25.2
Total cost of all work (hours)	425.0	$660.00	....	$1.553	100.0
Drawbar work:					
Fuel:					
Kerosene (gallons)	446.3	$ 69.53	1.39	$0.217	13.2
Gasoline (gallons)	129.1	31.96	0.40	0.100	6.1
Total fuel for drawbar work (gallons)	575.4	101.49	1.79	0.316	19.2
Costs other than fuel and operator	....	268.77	....	0.838	50.9
Cost of tractor without operator	....	370.26	....	1.154	70.1
Tractor operator (hours)	319.3	157.88	0.99	0.492	29.9
Total cost of drawbar work (hours)	320.8	528.14	....	1.646	100.0
Belt work:					
Fuel:					
Kerosene (gallons)	172.4	$ 27.82	1.65	$0.267	21.1
Gasoline (gallons)	30.0	8.07	0.29	0.077	6.1
Total fuel for belt work (gallons)	202.4	35.89	1.94	0.344	27.2
Costs other than fuel and operator	....	87.22	....	0.837	66.2
Cost of tractor without operator	....	123.11	....	1.181	93.4
Tractor operator (hours)	14.0	8.75	0.13	0.084	6.6
Total cost of belt work (hours)	104.2	131.86	....	1.265	100.0

The costs of tractor operation given in table 6 are the average costs of all makes and sizes of tractors found on these farms. The average costs of operation for two-plow and for three-plow tractors, separately, are given in table 37, (page 117). The comparative average costs of operation for tractors operated on kerosene and on gasoline are given in table 15, (page 76). The average costs per hour of recent and of older models of tractors are shown in table 7. A somewhat larger proportion of the plowing and harrowing on these farms was done by the newer tractors. Belt work constituted a slightly larger proportion of the work done by the older tractors, and drawbar work a slightly smaller proportion of their

work, but the differences were not important. The tractors that were new in 1918 and 1919 were used a somewhat larger number of hours than were the older tractors, but the difference in the cost per hour of work was not great. The lower cost of depreciation on the older tractors was offset to a considerable extent by higher repair and other costs.

TABLE 7. RELATION OF AGE OF TRACTOR TO COST OF OPERATION AND OTHER FACTORS

	Tractors new in			
	Spring of 1919	1918	1917	1916 to 1913
Number of tractors	17	29	20	13
Per cent of plowing done by tractor	79	75	48	24
Per cent of harrowing done by tractor	95	82	67	70
Per cent of disking done by tractor	99	99	100	96
Average hours of work per tractor in 1919	433	513	329	371
Costs per hour of tractor operation:				
Depreciation	$0.54	$0.40	$0.43	$0.26
Repairs, new parts, and expert labor	0.03	0.07	0.23	0.11
Interest	0.13	0.09	0.09	0.05
Work on tractor by farm labor	0.06	0.07	0.15	0.10
Lubrication	0.10	0.09	0.11	0.06
Use of buildings	0.01	0.01	0.01	0.01
Fuel	0.31	0.31	0.32	0.38
Other costs	....	0.01	0.04	....
Cost of tractor without operator	$1.18	$1.05	$1.38	$0.97

DEPRECIATION

The most important single item of tractor cost is depreciation (table 6). Its importance is frequently overlooked, however, and in popular practice it is often omitted in computing the cost of tractor work. The average cost, average value, depreciation, and other data on the tractors studied, are shown in table 8:

TABLE 8. AVERAGE COST, LENGTH OF USEFUL LIFE, AND ANNUAL DEPRECIATION OF TWO- AND THREE-PLOW TRACTORS ON 87 FARMS

Rated capacity of tractor	Number of tractors	Rated horse-power	Average cost when new, per tractor	Average value in 1919	Number of seasons used	Total estimated useful life (years)	Annual depreciation in 1919
Two-plow	70	8.7–17.1	$ 923	$624	2.1	5.8	$177.37
Three-plow	15	10.8–21.3	1,309	824	2.5	6.9	221.67
Total	87*	....	......	......	......	......	....
Average	......	9.1–17.9	$992	$662	2.2	6.0	$187.25

* Two of the 87 farms from which data were obtained exchanged two-plow for three-plow tractors during the year. These could not be included in either the two- or the three-plow group, but are included in the averages.

The average cost of the two-plow tractors was $923 when new. The average cost of the three-plow tractors was $1309, and the average of all was $992. The estimated average value of all tractors in 1919, after an average of 2.2 years of use, was $662. The owners expected to receive an average of 3.8 years of additional satisfactory service, making the estimated average useful life 6 years. The average depreciation for the year 1919 was $187.25 per tractor for all machines, the amount being somewhat larger for three-plow than for two-plow tractors. This depreciation was computed from estimates, made by owners, of the value of tractors at the beginning and at the end of the year, the cost of tractors bought during the year, and the amount received for tractors sold or exchanged during the year.

Many of these tractors are comparatively new, and depreciation is therefore heavy. Depreciation is normally heavier on new machines, decreasing as the machines grow older, but the annual cost of repairs increases with the age of the machine (table 9). The average costs of

TABLE 9. RELATION OF AGE OF TRACTOR TO DEPRECIATION AND COST OF REPAIRS ON 87 FARMS

	Tractors new in			
	Spring of 1919	1918	1917	1916 to 1913
Number of farms	17	29	20	13
Average cost of tractors when new	$1,085	$1,038	$913	$892
Total years of estimated useful life	6.4	7.0	5.9	5.5
Average value in 1919	$969	$749	$501	$295
Average depreciation in 1919	$233	$207.76	$142.50	$98.08
Average cash cost of repairs, new parts, and expert labor	$14.57	$37.20	$74.99	$39.22
Average cost of repairs and depreciation	$247.57	$244.96	$217.49	$137.30

repairs and depreciation in the year 1919 for tractors bought in 1919, 1918, and 1917, are approximately equal, but they decrease for older machines. The tractors new before 1917 were so nearly worn out that depreciation was much lower. The estimated useful life of the newer tractors is somewhat greater than for the earlier models. With improvement in design and construction, this result would be expected. Possibly the greater estimated life of newer tractors is due somewhat to the optimism of less-experienced owners.

The heavy depreciation on tractors is an expression of the fact that their period of useful life is short. The great diversity of types of tractors is sufficient proof of this fact. Depreciation is always heavier on newly invented machines, and the tractor is no exception to this rule.

The length of life of a tractor is often expressed in the hours of work which it will do. Depreciation on machines that are changing rapidly

goes on whether the machine is used or not. The amount of work done is only one of the factors affecting depreciation. Up to the present time, relatively few tractors have been worn out, but many have been discarded because obsolete. Although depreciation is greater on tractors which are worked harder, it is not proportional to the hours of work done (table 10). The estimated total years of useful life was less for the tractors that were used the most, as would be expected, but the cost of depreciation per hour of tractor work decreased as the hours of tractor work increased. Multiplying the average useful life in years of the tractors in each group by the average hours of work for the year 1919 would give the estimated total working life in hours under these conditions. It is apparent from inspection that the average working life of a tractor increases with the hours of work done annually, from about 1280 hours in the lowest group to about 4200 hours in the highest group.

TABLE 10. RELATION OF AMOUNT OF WORK DONE BY TRACTOR TO DEPRECIATION

Hours of tractor work in 1919	Number of farms	Estimated useful life of tractor (years)	Average hours of tractor work per farm in 1919	Average annual depreciation per tractor	Depreciation per hour of tractor work	Average value per tractor in 1919
Less than 300......	31	6.3	203	$164.03	$0.81	$559
300–399...........	21	6.3	360	178.33	0.50	744
400–499...........	13	5.5	449	222.00	0.49	703
500–799...........	13	5.8	636	201.92	0.32	739
800 or more.......	9	4.2	1,001	216 67	0.22	654
Total.........	87	....	....	....	....	....
Average.......	....	6.0	425	$187.25	$0.44	$662

REPAIRS, NEW PARTS, AND EXPERT LABOR

Included in repairs, new parts, and expert labor are cash costs of all repairs and new parts, hired expert labor, and freight and express on parts, as well as costs of telegraph and telephone and railroad fare to get parts. The outlay for these items on different farms was exceedingly variable, ranging from nothing to $454 for the year 1919. The expenses given in table 11 include only actual cash outlay. In addition to these amounts, free service was given the first year to some tractor owners, and defective parts were replaced free, or at reduced prices in some cases. On one tractor, a defective oiling system was replaced and other new parts and service worth about $120 were furnished without charge. Ten farmers out of 87 reported no outlay for repairs or expert labor on their tractors in 1919. One of these tractors was an old machine used only for belt

work. Another gave out during the year and was junked because it was not worth repairing. The other eight were used for ordinary tractor work throughout the year. The average outlay per farm was $44.25, or about 10 cents per tractor hour. More detailed information on the important classes of repairs is given in table 11:

TABLE 11. Repairs, New Parts, and Expert Labor on Tractors on 87 Farms

	Number of farms reporting expense	Average cost per tractor, all farms
Motor:		
Cylinders	4	$4.15
Cylinder head	4	0.87
Crank case	1	0.11
Crank shaft	2	0.83
Exhaust pipe	1	0.05
Welding flywheel	1	0.16
Starting cranks	2	0.04
Motor bearings	22	4.20
Pistons and rings	14	1.22
Valves	4	0.11
Total motor expenses	....	$11.74
Ignition:		
Igniter	5	$0.23
Magneto	13	2.34
Spark plugs	51	3.03
Timers	15	0.61
Total ignition expenses	....	$6.21
Transmission:		
Chain links	8	$1.37
Clutch	1	0.04
Sprocket	3	0.72
Transmission bearings	4	0.88
Transmission gears	20	5.28
Total transmission expenses	....	$8.29
Cooling system:		
Fans	3	$0.17
Fan belts	22	0.91
Radiator	1	0.40
Total expenses for cooling system	....	$1.48
Running gear:		
Axle	4	$0.36
Bearings for wheels	3	0.25
Steering wheel	4	0.40
Track and track pins	3	2.36
Track wheels	2	0.94
Wheels	3	1.44
Total expenses for running gear	....	$5.75

TABLE 11 (*concluded*)

	Number of farms reporting expense	Average cost per tractor, all farms
Miscellaneous parts	15	$0.66
Miscellaneous costs:		
Expert labor	35	$8.15
Freight and express	9	1.38
Railroad fare	5	0.48
Telephone and telegraph	5	0.11
Total miscellaneous costs	....	$10.12
Total of all expenses	....	$44.25

During the busy season the time necessary to get repair parts and extras is usually of more importance than their cost. In general, better service on parts was obtained by the tractor owners in the general farming region than in the fruit region. The average amount of time necessary to get parts in Cayuga County was about 11 hours, as compared with 72 hours in the fruit region. Parts or expert mechanics for their tractors were available to 41 of the 46 Cayuga County tractor owners at no greater distance than Auburn. In case of emergency, a trip to Auburn from most of the farms could be made by automobile in less than a half day, thus avoiding unnecessary delay. In the fruit region, 29 of the tractor owners depended on express or mail service to get parts, as service stations were not within easy driving distance by automobile. The average amount of time necessary for these men to get parts was 4.1 days, or 98 hours. The remaining 12 farmers owned tractors for which parts could be procured locally, and the average time necessary for these men to get parts, by automobile, was two hours. For all farms in the region, the average amount of time necessary to get parts was about three days. In many cases, poor mail or express service made the delay much greater.

In deciding on the kind of tractor to purchase, the importance of quick service on repairs can scarcely be overestimated. Even with the best of tractors, given the best of care, occasional breaks will occur, and the tractor company that gives the best service on parts and repairs has a great advantage. One tractor owner who was visited had broken the crank shaft of his tractor in May — in the midst of the greatest pressure of spring work. A branch service station for his tractor was maintained at Auburn which was supposed to carry a complete line of parts, but to

his regret he was told that there was no crank shaft in stock as no one had ever broken one before in this region. When he was visited, his tractor had been idle for three weeks waiting for a new crank shaft to come from the factory, and in order to get his crops in at all he was forced to buy another tractor. Many other reports of unsatisfactory service were received from other tractor owners. One man whose new tractor burned out a connecting-rod bearing after only four days of work in filling a silo, ordered the new parts by wire from the factory. It was eighteen days before the parts were shipped from the factory, and three days more before they arrived.

In the rapid change in types of tractors from year to year, the tractor companies have frequently failed to keep in stock parts of models one or two years old. One owner whose tractor gave out in the busy season lost nine weeks while the company was making the parts required.

At the present time, much more attention is being given than formerly to the question of service by tractor manufacturers. They are beginning to realize that satisfied users are their best assets in making future sales, and that prompt, efficient, satisfactory service at reasonable cost is essential in keeping users satisfied.

The difference in the amount of time necessary to get parts in the two regions studied had an important effect on the average number of days that these tractors were disabled during the busy season. In Cayuga County, the average number of days disabled for all tractors was 1.5. The days disabled ranged from none to 14. Nineteen out of 46 tractor owners reported no time lost during the busy season. In the fruit region, the average number of days disabled for all tractors was 9. Four tractors were disabled for a total of 315 days, or an average of 79 days each. Except for these four tractors, the average number of days disabled was 1.7. Nineteen out of 41 tractor owners reported no time lost.

The age of the tractor also is important in regard to the amount of time lost by breakdowns. Combining the figures for both regions visited, the average number of days disabled was 0.4 for tractors new in the spring of 1919, 1.7 for tractors new in 1918, 4.3 for tractors new in 1917, and 14.9 for tractors new in 1913 to 1916. The difference is probably due partly to the greater reliability of new tractors and partly to improved construction of the recent models. Machines are ordinarily discarded because of the danger that they will break at a critical time, rather than because of the actual cash outlay for repairs.

The average cost of repairs in the year 1919 for tractors working less than 300 hours annually was $34.30. The average annual outlay for repairs increased uniformly with the increase in the hours of work, being $69.68 per tractor for tractors working from 500 to 799 hours annually,

and \$79.77 for tractors working more than 800 hours for the year. The increased cost was not proportional to the increase in the amount of work done, the cost of repairs per hour of work decreasing from about 17 cents an hour for tractors working less than 300 hours to 11 and 8 cents an hour, respectively, for the other groups mentioned.

INTEREST

Interest at the rate of 6 per cent yearly on the average value of tractors at the beginning and at the end of the year was charged as an expense of tractor operation. This amounted to an average of \$39.72 per tractor, or about 9 cents for each tractor hour.

WORK ON TRACTOR BY FARM LABOR

Work on the tractor by the tractor operator or other farm help was charged at the cost per hour of the tractor operator as computed for each farm. This work includes the regular routine work of oiling and filling the tractor once or twice a day — comparable to chores on horses or other animals — repairing and overhauling the tractor, hauling oil or fuel, and getting new parts or getting an expert. Incidental filling up with fuel and water, or minor adjustments made while operating, were not included as work on tractor.

The daily chores on tractors amounted to 38.4 hours per tractor for the year (table 12), or about 0.9 hour for every 10 hours of tractor work. There was much variation in the amount of time spent in chores on

TABLE 12. WORK ON TRACTORS BY FARM LABOR, 87 FARMS

Kind of work	Total — 87 farms (man hours)	Per tractor (man hours)
Daily chores	3,338.4	38.4
Repairs and overhauling	2,894.0	33.3
Hauling oil or fuel	51.0	0.6
Getting new parts	244.0	2.8
Getting experts	26.5	0.3
Total	6,553.9	75.3

tractors, the average amount of time spent per working day ranging from fifteen minutes to two and one-half hours. Chores constituted about one-half of the work on tractors by farm labor, the remainder being made up of repairs, overhauling, drawing oil or fuel, and getting parts or experts. More time is required in chores and other work on the older tractors than on the newer machines. On the average, 51.1 hours of work were

spent per tractor, for the year, on tractors new in the spring of 1919, 73.6 hours on tractors new in 1918, 79 hours on tractors new in 1917, and 85.5 hours on tractors new in 1913 to 1916. The average hours of chores, repairs, and other work on the tractor for each working day of ten hours were, respectively, 1.18 hours, 1.43 hours, 2.40 hours, and 2.30 hours. On the average, with all tractors, 1.77 hours of man labor in chores and repairs on the tractor were required for every ten hours of tractor work done. Much of the work of repairing and overhauling was done at seasons of the year when field work was not pressing.

LUBRICATION

The cost of lubrication included the cost of cylinder oil, transmission oil or grease, and cup grease, together with any freight or other transportation charges paid on these materials. An average of 1.24 gallons of cylinder oil, costing 71 cents, was used per 10-hour day on these farms, or a total of nearly 53 gallons a year (table 13). The average cost of oil was 57.5 cents a gallon, and of grease, 15.7 cents a pound.

TABLE 13. COSTS OF TRACTOR LUBRICATION ON 87 FARMS

	Per tractor annually		Per 10-hour day	
	Quantity	Value	Quantity	Value
Cylinder oil	52.9 gallons	$30.33	1.24 gallons	$0.71
Transmission oil	7.1 gallons	4.18	0.17 gallon	0.10
Total oil	60.0 gallons	$34.51	1.41 gallons	$0.81
Cup grease	17.4 pounds	$2.63	0.41 pound	$0.06
Transmission grease	2.1 pounds	0.44	0.05 pound	0.01
Total grease	19.5 pounds	$3.07	0.46 pound	$0.07
Total cost of lubricants	....	$37.58	....	$0.88

Transmission oil was used on most tractors having gear transmission, but a semi-solid grease was used in a few cases. The amount of cylinder oil used per day varied widely on different farms. One farmer reported using less than two quarts of oil a day, while others reported as much as two to three gallons a day. The amount of oil used is influenced by the kind of oiling system, by the kind of fuel used, and by the mechanical condition of the tractor. In general, the tractors using a splash oiling system or a combination of the splash and pump system, used somewhat more oil than those using only the pump system. The disadvantage of using more oil seemed to be more than offset, however, by less trouble

with burned-out bearings and better general satisfaction. Somewhat less cylinder oil was used with gasoline as fuel than with kerosene. The average of 12 tractors of recent model using gasoline was 1.28 gallons of oil per 10-hour day, while the average of 32 tractors of recent model using kerosene was 1.59 gallons per 10-hour day. With tractors using kerosene as fuel, some kerosene gets by the piston rings and thins out the oil in the crank case, so that the oil must be renewed more frequently than when gasoline is used. Probably the mechanical condition of the tractor is the most important factor affecting economy of oil. One user reported that his tractor had used as much as 10 gallons of oil in a day, due to bad mechanical condition. After the tractor was repaired, the oil consumption was reduced to a normal amount.

USE OF BUILDINGS

The cost of shelter for a tractor was computed from the approximate value of the building or the part of a building used to house the tractor, and the farm cost of building maintenance. The value of the building or part of a building used to shelter the tractor was estimated by the writer. The cost of building maintenance, including interest, taxes, and other costs of upkeep, was estimated at 9.6 per cent of the average value of the building occupied. This is the average rate of maintenance of farm barns for the years 1915 to 1919 on New York farms on which complete cost accounts have been kept in cooperation with the Department of Agricultural Economics and Farm Managament of Cornell University and the Office of Farm Management of the United States Department of Agriculture.

On 19 farms out of 87, a special tractor garage or shed was used for housing the tractor, the average investment in tractor shelter for these farms being $74.21 per farm. On 65 farms, a part of an existing barn or shed was utilized for housing the tractor, the average investment in tractor shelter for these farms being $44.69. On 3 farms, the tractor stood outdoors all the year without any shelter. These were all old models of tractors which would not be seriously damaged by such treatment. On 2 farms, insurance rates were increased because of housing the tractor in the barn, and this increased cost of insurance was added to the cost of building maintenance for the tractor. The average investment in tractor shelter for all farms was $49.50 per farm, and the estimated total cost of use of buildings chargeable to the tractor was $4.82 per tractor for the year, or 1.1 cents per tractor hour.

INSURANCE

Only 13 out of the 87 farmers visited had taken out any special fire insurance on their tractors. In the other cases, no increase had been

made in the amount of insurance carried on farm machinery to cover the additional investment in tractors. Only the cost of additional special insurance on tractors is included here as expense. This amounted to an average of 35 cents a farm for all farms.

AUTOMOBILE USE AND HORSE LABOR

Use of automobiles, trucks, or horses for getting parts for tractors, for getting experts, or for drawing oil or fuel, was charged to the tractors at estimated cost. For automobile use the cost was estimated at 10 cents a mile, and for horse labor the approximate average cost on the cost-account farms for 1919, 25 cents per horse hour, was used.

FUEL

Although it is the chief item of expense of tractor operation ordinarily considered, the fuel cost constituted less than one-fourth of the total annual cost of tractor operation on the farms studied. The average cost of kerosene on these farms for the year 1919 was 15.7 cents a gallon and the average cost of gasoline was 25.2 cents a gallon. With these prices the average cost of fuel was $137.38 per tractor for the year, or 32.3 cents per tractor hour, for all work done. With December, 1920, costs, 20 cents a gallon for kerosene and 32 cents a gallon for gasoline, the average cost would be $174.65 per tractor, or 41.1 cents per tractor hour, for all work. The amounts and costs of fuel per tractor and per hour on these farms are shown in table 14. With 1920 prices these costs would be increased about one-fourth.

TABLE 14. AMOUNTS AND COSTS OF FUEL FOR TRACTORS ON 87 FARMS

	Per tractor						Per 10-hour day					
	Two-plow tractors		Three-plow tractors		All tractors		Two-plow tractors		Three-plow tractors		All tractors	
	Gallons	Value	Gallons	Value	Gallons	Value	Gallons	Value	Gallons	Value	Gallons	Value
Kerosene...	506.1	$77.91	1,026.4	$168.10	618 7	$97.35	12.8	$1.97	18 9	$3.09	14.6	$2.20
Gasoline...	161.4	40.75	165.7	41.04	159.1	40.03	4.1	1.03	3 0	0 76	3.7	0.94
Total fuel..	667.5	$118.66	1,192.1	$209.14	777.8	$137.38	16.9	$3.00	21.9	$3.85	18 3	$3.23

Of the 46 Cayuga County farmers, 42 used kerosene as fuel except for necessary gasoline for starting, 3 used gasoline only, and 1 used gasoline and kerosene at different times during the year. Kerosene was used for fuel in all tractors that were built to use that fuel. Of 41 farmers in Monroe and Orleans Counties, 22 used kerosene, 13 used gasoline, 4 used a mixture of half kerosene and half gasoline, and 2 used kerosene part of the year and gasoline part of the year. Nine of the 13 tractors that

used gasoline were four-cylinder tractors of recent model constructed to use kerosene satisfactorily. Of the 22 tractors using kerosene, 13 were one- or two-cylinder tractors of older models and 9 were four-cylinder tractors of recent models. In this region, out of 22 four-cylinder tractors of recent model built to use kerosene, 9 were operated on kerosene, 8 on gasoline, 4 on half kerosene and half gasoline, and 1 a part of the year on kerosene and a part on gasoline. The use of gasoline instead of kerosene was encouraged by tractor dealers and agents on the grounds that with gasoline the saving in oil, spark plugs, repairs, and trouble would more than make up for the higher cost of fuel. There is also less trouble in starting when gasoline is used as fuel. In order to get information on this question, the two-plow, four-cylinder tractors of recent model were sorted according to the kind of fuel used. The results of this study are shown in table 15:

TABLE 15. RELATION OF KIND OF FUEL USED TO COST OF TRACTOR OPERATION AND OTHER FACTORS, IN TWO-PLOW TRACTORS OF RECENT MODELS

	Tractors using							
	Gasoline		Kerosene		Gasoline		Kerosene	
	Per tractor		Per tractor		Per hour		Per hour	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Number of farms	12	......	29	......	......	......	......	......
Average horsepower	9.4–18.3	......	8.6–16.8	......	......	......	......	......
Average cost when new	......	$1,009	......	$960	......	......	......	......
Estimated years of useful life	5.2	......	6.7	......	......	......	......	......
Chores on tractor (hours)	32.9	......	34.6	......	......	......	......	......
Repairs, overhauling, and other work (hours)	52.4	......	37.7	......	......	......	......	......
Total work on tractors by farm labor (hours)	85.3	......	72.3	......	......	......	......	......
Costs:								
Depreciation	......	$218.75	......	$190.55	......	$0.529	......	$0.478
Spark plugs	2.5	2.35	4.5	4.75				
Other repairs and expert labor	......	76.95	......	24.79	....	0.102	......	0.074
Interest	......	43.92	......	43.13	......	0.106	......	0.108
Work on tractor by farm labor (hours)	85.3	33.16	72.3	40.41	......	0.080	......	0.101
Oil (gallons)	52.9	29.97	67.2	39.91	0.13	0.072	0.17	0.100
Grease (pounds)	15.6	2.87	13.3	1.96	......	0.007	......	0.005
Use of buildings	......	5.80	......	4.27	......	0.014	......	0.011
Automobile use (miles)	57.8	5.78	25.8	2.58	......	0.014	......	0.006
Insurance	......	0.60	......	0.30	......	0.001	......	0.001
Horse labor (hours)	1.5	0.38	1.3	0.33	......	0.001	......	0.001
Costs other than fuel and operator	......	$420.53	......	$352.98	......	$1.017	......	$0.886
Kerosene (gallons)	......	......	647.1	$103.42	......	......	1.62	$0.260
Gasoline (gallons)	569.2	$139.71	17.6	4.61	1.38	0.338	0.04	0.012
Total fuel (gallons)	569.2	$139.71	664.7	$108.03	1.38	0.338	1.67	$0.271
Total cost of tractor without operator	......	$560.24	......	$461.01	......	$1.355	......	$1.157
Average hours worked	413.6	......	398.4	......	......	......	......	......

The average cost for the use of the tractor without operator on 29 farms using kerosene as tractor fuel, was about $1.16 an hour, while the cost on 12 farms using gasoline was $1.35 an hour. Probably this difference is not due entirely to the fuel used. Although more gallons of kerosene were used per hour, the fuel cost with 1919 prices was about 7 cents an hour less than when gasoline was used. This saving in fuel cost was partly offset by the greater economy of oil when gasoline was used. An average of about 1.3 gallons of oil was used per 10-hour day with tractors using gasoline, as compared with 1.7 gallons with tractors using kerosene. This resulted in a saving of 3 cents an hour when gasoline was used. Fewer new spark plugs were required with gasoline tractors, but this item is unimportant. Although the tractors were of about the same average age, the estimated total years of useful life of tractors using gasoline were lower, and, as a result, the estimated depreciation was larger, amounting to 52.9 cents an hour as compared with 47.8 cents for tractors using kerosene. The cost of repairs per tractor and per hour was also much higher for the tractors using gasoline. These variations are probably accidental, as there is no reason to expect higher depreciation or more repairs when gasoline is used as fuel than when kerosene is used.

Although fewer gallons of gasoline were required per 10-hour day and per acre for all kinds of work, the cost of fuel was less where kerosene was used, at the prices prevailing when this study was made (table 16).

TABLE 16. RELATION OF KIND OF FUEL USED TO FUEL ECONOMY IN DIFFERENT TRACTOR OPERATIONS, IN TWO-PLOW TRACTORS OF RECENT MODELS

	Fuel per 10-hour day				Fuel per acre			
	Tractors using kerosene		Tractors using gasoline		Tractors using kerosene		Tractors using gasoline	
	Gallons	Cost	Gallons	Cost	Gallons	Cost	Gallons	Cost
Plowing	17.3	$2.82	11.8	$2.96	3.85	$0 63	2.71	$0.68
Harrowing	15.9	2.48	14.8	3.62	0.66	0.10	0.64	0.16
Disking	16.4	2.67	13.4	3.28	0.93	0.15	0 82	0.20
Filling silo	16.5	2.71	11.7	2.87	....	......	......	....
Threshing	17 3	2.93	12.5	3.42	....	......	......	....
Sawing wood	11.4	1.90	9.8	2.42	.....	......	......	....
Total drawbar work	16 6	2.69	13.9	3.42	......	......	......	....
Total belt work	17.1	2.82	11.5	2.82	.....	.....	......	....
Total work	16.7	2.71	13.8	3.38	.....	...	.....	....

For all work, with these two-plow tractors, an average of 16.7 gallons of fuel, costing $2.71 per 10-hour day, was required when kerosene was used, as compared with 13.8 gallons of fuel costing $3.38 per 10-hour day when gasoline was used. The small amount of gasoline necessary for starting kerosene tractors was included with the kerosene in fuel cost. With December, 1920, fuel prices and with the quantities given, the cost of kerosene per hour would be about 10 cents less than the cost of gasoline.

tractors. The average costs of operation with these classes of operators are shown in table 19:

TABLE 19. RELATION OF MECHANICAL TRAINING OF TRACTOR OPERATOR TO COST OF TRACTOR OPERATION

	Costs per hour of tractor operation					
	Tractor school		Other mechanical experience		Only farm experience	
	Quantity	Value	Quantity	Value	Quantity	Value
Number of farms	23	......	21	......	43	....
Depreciation	......	$0.421	......	$0.488	......	$0.417
Repairs, new parts, and expert labor	......	0.078	......	0.120	......	0.119
Interest	......	0.079	......	0.105	......	0.095
Work on tractor by farm labor (hours)	0.195	0.090	0.166	0.091	0.177	0.092
Lubrication	......	0.076	......	0.095	......	0.093
Use of buildings	......	0.009	......	0.015	......	0.011
Automobile use	......	0.005	......	0.004	......	0.009
Insurance	......	0.001	......	0.001	......	0.001
Horse labor	......	0.001	......	0.001	......	0.001
Total costs other than fuel and operator	......	0.760	......	0.920	......	0.838
Kerosene (gallons)	1.46	0.221	1.35	0.223	1.46	0.229
Gasoline (gallons)	0.42	0.103	0.44	0.108	0.32	0.083
Total fuel (gallons)	1.88	0.324	1.79	0.331	1.78	0.312
Cost of tractor without operator	......	1.084	......	1.251	......	1.150
Average hours worked per tractor	459.6	......	442.4	......	407.9	....

These results indicate that even the limited amount of training acquired by these operators at tractor schools was effective in helping to reduce the cost of tractor operation. On these farms the tractor operators who had been to tractor schools spent a little more time in taking care of their tractors, and apparently were thus able to reduce the cost of repairs per hour. The average number of days spent in tractor schools was 5.3. Only two operators had had more than a week of work in tractor schools. One of these had attended two schools of a week each, and the other had taken a special five-weeks tractor course at the New York State College of Agriculture. The average cost of attending a tractor school, including all expenses except time lost, was $12.79. In only two cases was the cost more than $15, and these were the cases of the two men previously mentioned as having had more than one week of training. The cost of attending tractor school was not included in the cost of tractor operation. It would increase these costs slightly. The estimated average cost per

hour of the tractor operator was 45 cents for those who had been to a tractor school, and 51 cents for others.

DRAWBAR WORK COMPARED WITH BELT WORK

The kind of fuel used, and the hours of tractor operator's time for each kind of drawbar and belt work on each farm, were estimated by the farmers visited. Thus the fuel and tractor-operator costs could be computed for each operation and for the two classes of tractor work. It is manifestly impossible, however, to distribute to each kind of work its exact share of depreciation, repairs, use of buildings, labor, and other costs. As in some previous studies,[1] the costs other than those for fuel and operator were distributed according to the number of hours of each kind of work. By this method, the average cost of a tractor without operator was $1.15 an hour for drawbar work and $1.18 an hour for belt work. A considerable number of farmers used their tractors largely for filling silo and for threshing — heavy belt work with a correspondingly heavy consumption of fuel. Because of this the average consumption of fuel per hour of belt work was slightly greater than the consumption of fuel per hour of drawbar work. The actual average fuel consumption per hour was 1.94 gallons for belt work and 1.79 gallons for drawbar work (table 6, page 64). The total cost of tractor and operator per hour was higher for drawbar work, being $1.65 as compared with $1.26 for belt work. This is because a tractor operator is not necessary continuously when the tractor is being used for belt work. On the average, only 0.13 hour of tractor operator's time was required for each hour of belt work, while with drawbar work an operator is required continuously.

A study was made of these farms to determine the relation, if any, between the proportion of belt work done and the cost per hour of tractor work. For this purpose the tractors were sorted into three groups: first, those doing little or no belt work; secondly, those doing a moderate amount of belt work; and thirdly, those doing a large amount of belt work. The results indicated that on these farms the proportion of belt work had no appreciable effect on the cost per hour of tractor operation.

It might be expected that depreciation and other costs except fuel would be heavier for drawbar than for belt work. The dust, the racking of the running gear and transmission over rough or stony ground, and other factors, would tend to increase the costs of depreciation and repairs. Opinions on this question of the farmers visited were conflicting. Thirty-six farmers who answered the question reported an average estimate of 50 per cent heavier depreciation on drawbar work. Men with older

[1] An economic study of the gas tractor in Pennsylvania. By D. S. Fox. Pennsylvania State Coll. Agr. Exp. Sta. Bul. 158 : 1–20. 1919.

models of tractors usually estimated the rate of depreciation on drawbar work as from two to three times the rate of depreciation on belt work. Probably these estimates are not far from the truth with the older, heavier tractors, unprotected from dust. The improvements in protection against dust, in design, and in construction, have made the difference less, and many owners of newer tractors thought there was little difference in depreciation with the two classes of work.

ANNUAL USE OF TRACTORS

RELATION OF HOURS OF ANNUAL USE TO COST OF OPERATION

The average number of hours of work per tractor on the 87 farms visited was 425 hours. The figure was somewhat higher in the general farming region, being 456 as compared with an average of 390 in the fruit region (tables 21 and 22). The average number of hours of work per tractor for the farmers sending in complete answers to questionnaires was 334. There was a great deal of variation in this respect on individual farms, the range extending from 47 to 1277 hours per tractor annually. While these figures seem low, it should be remembered that the average farm horse in New York works only about 1000 hours in a year. Tractors are not so adaptable as horses, and could not be expected to be kept profitably employed as many hours per year as are horses on most farms. A partial offset to this advantage of horses is the fact that on many farms tractors are used to a considerable extent for belt power.

Depreciation, repairs, and most other costs of tractor operation are greater when more work is done annually. However, the increase in costs, except for oil, fuel, and tractor operator, is not proportional to the increase in the hours of work done. As shown by table 20, the costs per hour of tractor work decrease as the hours of work increase. This emphasizes the importance of keeping the tractor busy if operating costs are to be kept down. It is not enough that a tractor be kept busy; it must be kept busy at profitable work. The general opinion of the farmers visited indicates that the important question is not "For what operations can I use my tractor?" but "For what operations will it pay to use my tractor?" The answer of the first question by tractor salesmen is "Everything," and this is approximately true. By exchanging work, two of the farmers visited had succeeded in operating their farms for one year without owning horses. At the end of the year, both bought horses because there are many kinds of work on New York farms for which it does not pay to use a tractor.

The number of hours that a tractor can be profitably used on New York farms depends on a number of conditions. Perhaps the most

important of these is the size of the farm business. If the tractor is used for belt work in addition to drawbar work, the number of hours of annual use will be increased considerably. The kind of crops grown, the soil, the drainage, and weather conditions will also have an effect on the amount of annual use of the tractor.

TABLE 20. Relation of Hours of Work per Tractor Annually to Cost of Operation per Hour

	Hours of tractor work annually							
	1 to 299		300 to 399		400 to 799		800 or more	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Number of farms	31	....	21	......	26	....	9	....
Average hours of work per tractor annually	203	....	360	.....	542	.....	1,001	....
Per cent of drawbar work	88.8	....	82.2	.....	72.9	..	64.8	......
Costs of all work:								
Oil (gallons)	0.17	$0.100	0.14	$0.084	0.15	$0.083	0.11	$0.063
Grease (pounds)	0.07	0.009	0.05	0.009	0.04	0.007	0.03	0.004
Total lubricants	..	0.109	.....	0.093	....	0.090	.....	0.067
Use of buildings	.....	0.021	......	0.014	......	0.008	......	0.008
Repairs, new parts, and expert labor	..	0.169	.....	0.065	.....	0.112	..	0.079
Man labor (hours)	0.25	0.123	0.13	0.066	0.20	0.107	0.13	0.066
Horse labor	..	0.001	...	0.001	.....	0.001		0.000
Automobile use	....	0.022	..	0.001	.....	0.004	.....	0.005
Depreciation	..	0.809	....	0.495	...	0.391	......	0.216
Interest	.....	0.165	.....	0.124	....	0.080	...	0.039
Insurance	....	0.001	.	0.001	..	0.001	..	0.001
Total costs other than fuel and operator	..	$1.420	.	$0.860	.	$0.794	......	$0.481
Kerosene (gallons)	1.45	$0.223	1.43	$0.229	1.61	$0.249	1.25	$0.203
Gasoline (gallons)	0.32	0.080	0.35	0.086	0.24	0.060	0.64	0.163
Total fuel (gallons)	1.77	$0.303	1.78	$0.315	1.85	$0.309	1.89	$0.366
Cost of tractor without operator	......	$1.723	......	$1.175	.....	$1.103	.....	$0.847

KINDS AND AMOUNTS OF WORK DONE BY TRACTORS

The amounts and proportions of the various kinds of work for which tractors were used in the two regions studied, and also on farms from which information was obtained by the use of questionnaires, are shown in tables 21, 22, and 23. In the general farming region, plowing and fitting for field crops were the most important operations, making up about 57 per cent of the total work. Tractors were used for these operations by nearly all of the farmers. Pulling a grain binder and pulling a hay loader were the only other field operations for which tractors were used by any considerable number of farmers. Drawbar work at home constituted about 60 per cent of the total tractor work in this region. One-half of the farmers visited in this region did some custom drawbar work, the average hours per farm for all farms being 23.8, or 5.2 per cent

TABLE 21. KINDS OF WORK DONE BY TRACTORS ON 46 FARMS IN CAYUGA COUNTY, A GENERAL FARMING REGION

	Number of farms reporting	Average per farm, all farms					Fuel per 10-hour day		Acres per 10-hour day of tractor work	Per cent of total hours of tractor work
		Acres	Tractor operator hours	Other man hours	Tractor hours	Average size of tool used	Gallons	Cost		
Drawbar work, home:										
Plowing	44	65.5	135.3	0	135.3	2.3–13.8″	19.6	$3.30	4.8	29.7
Harrowing	36	129.2	53.8	0	53.8	11.5′	19.2	3.21	24.0	11.8
Disking (double)	38	107.8	69.2	0	69.2	7.6′	20.4	3.39	15.6	15.2
Binding grain	9	8.5	5.2	5.2	5.2	6.4′	12.1	2.06	16.3	1.1
Loading hay	11	9.4	3.3	5.5	3.3	....	14.7	2.87	......	0.7
Hauling	3	......	1.0	0	1.0	....	17.5	2.91	......	0.2
Pulling corn binder	2	0.6	0.9	0.9	0.9	....	10.1	1.59	6.7	0.2
Drilling	1	0.9	0.4	0.4	0.4	....	15.2	2.69	22.5	0.1
Raking	1	1.1	0.4	0	0.4	....	16.0	2.51	27.5	0.1
Pulling trees and brush	3	......	0.4	0	0.4	....	12.8	2.65	......	0.1
Mowing	1	0.5	0.4	0	0.4	6′	16.0	2.51	12.5	0.1
Moving buildings	3	......	0.3	0	0.3	....	18.1	2.93	......	0.1
Pulling manure spreader, 0.6 load	1	......	0.2	0.1	0.2	....	15.0	2.55	.....	0.04
Pulling horse fork	1	......	0.1	0	0.1	....	15.0	2.25	......	0.02
Rolling	1	0.4	0.1	0	0.1	....	14.2	2.58	40.0	0.02
Total drawbar work, home	46	......	271.0	12.1	271.0	....	19.5	3.26	......	59.5
Drawbar work, custom:										
Plowing	21	8.6	17.2	0	17.2	2.4–13.6″	21.1	$3.57	5.0	3.8
Harrowing	1	4.6	1.5	0	1.5	....	19.3	3.42	30.7	0.3
Disking (double)	10	8.5	5.0	0	5.0	....	19.4	3.26	17.0	1.1
Pulling trees	1	......	0.1	0	0.1	....	10.0	2.40	......	0.02
Scraping roads	1	......	0.02	0	0.02	....	30.0	5.40	......	0.004
Total drawbar work, custom	23	......	23.8	0	23.8	....	20.7	3.49	......	5.2
Total drawbar work	46	......	294.8	12.1	294.8	....	19.6	$3.28	......	64.7

Belt work, home:										
Filling silo	24	......	1.0	0	7.7	....	22.3	$3.78	......	1.7
Threshing	23	......	2.1	0	16.1	....	21.4	3.62	......	3.5
Sawing wood	28	......	0.7	0	6.3	....	12.1	2.11	......	1.4
Grinding feed	19	......	1.3	0	12.1	....	20.8	3.41	......	2.6
Husking corn	9	......	0.4	0	3.0	....	18.0	3.00	......	0.7
Total belt work, home	39	......	5.5	0	45.2	....	20.0	3.35	......	9.9
Belt work, custom:										
Filling silo	18	......	3.0	21.6	19.8	....	24.3	$4.19	......	4.3
Threshing	20	......	8.4	82.3	72.1	....	21.9	4.08	......	15.9
Sawing wood	7	......	0.4	5.2	4.3	....	11.4	1.79	......	0.9
Grinding feed	9	......	0.5	21.3	5.3	....	18.3	2.94	......	1.2
Husking corn	3	......	4.9	4.8	14.3	....	19.2	3.19	......	3.1
Total belt work, custom	34	......	17.2	135.2	115.8	....	21.4	3.85	......	25.4
Total belt work	39	......	22.7	135 2	161.0	....	21.0	$3.71	......	35.3
Total home work	46	......	276.5	12.1	316.2	....	19.5	$3.27	......	69.4
Total custom work	40	......	41.0	135 2	139.6	....	21.3	3.79	......	30.6
Total work	46	......	317.5	147 3	455.8	....	20.1	3.43	....	100.0

TABLE 22. KINDS OF WORK DONE BY TRACTORS ON 41 FARMS IN MONROE AND ORLEANS COUNTIES, A FRUIT REGION

	Number of farms reporting	Average per farm, all farms					Fuel per 10-hour day		Acres per 10-hour day	Per cent of total hours of tractor work
		Acres	Tractor operator hours	Other man hours	Tractor hours	Average size of tool used	Gallons	Cost		
Drawbar work, home:										
Plowing in orchard	8	3.0	5.8	0	5.8	2.1–13.7″	16.2	$2.93	5.2	1.5
Other plowing	27	18.4	41.8	0	41.8	2.1–13.6″	16.9	2.83	4.4	10.7
Harrowing in orchard	30	275.1	117.9	0	117.9	11.3′	16.2	3.21	23.4	30.2
Other harrowing	34	92.3	44.5	0	44.5	11.5′	15.8	2.85	20.7	11.4
Disking in orchard (double)	29	104.3	58.2	0	58.2	7.6′	18.3	3.33	17.9	14.9
Other disking (double)	31	65.1	38.8	0	38.8	7.7′	16.5	3.07	16.8	9.9
Disking and harrowing in orchard	3	2.1	1.3	0	1.3	....	16.2	2.38	16.2	0.3
Other disking and harrowing	5	23.5	13.2	0	13.2	....	17.8	2.95	17.8	3.4
Ditching	1	......	7.3	0	7.3	....	12.1	2.26	......	1.9
Pulling trees	7	......	5.7	0	5.7	....	12.6	2.88	......	1.5
Hauling	2	......	2.9	0	2.9	....	18.3	2.66	......	0.7
Pulling manure spreader	1	......	1.8	1.8	1.8	....	10.6	1.56	......	0.5
Spraying	1	......	1.5	0	1.5	....	12.0	2.87	......	0.4
Moving buildings	1	......	0.2	0	0.2	....	20.0	3.00	......	0.1
Pulling potato digger	1	0.05	0.1	0	0.1	....	20.0	2.00	5.0	0.03
Total drawbar work, home	40	......	341.0	1.8	341.0	....	16.5	3.06	......	87.3
Drawbar work, custom:										
Plowing	29	0.8	1.5	0	1.5	....	14.0	$2.53	5.3	0.4
Harrowing	3	6.8	1.6	0	4.1	....	12.4	2.56	16.6	1.0
Disking (double)	5	6.3	2.9	0	3.5	....	14.6	3.31	18.0	0.9
Total drawbar work, custom	7	......	6.0	0	9.1	....	13.6	2.84	15.2	2.3
Total drawbar work	40	......	347.0	1.8	350.1	....	16.4	$3.05	......	89.7

Belt work, home:										
Filling silo	10	......	0.6	......	4.6	....	14.6	$2.83	......	1.2
Threshing	1	......	0.1	......	0.7	....	15.7	3.86	......	0.2
Sawing wood	30	......	1.3	......	13.5	....	11.5	2.10	......	3.5
Grinding feed	11	......	0.6	......	6.3	....	13.3	2.78	......	1.6
Total belt work, home	32	......	2.6	......	25.1	....	12.6	2.45	......	6.4
Belt work, custom:										
Filling silo	2	......	0.04	0.3	0.4	....	12.5	$2.50	......	0.1
Sawing wood	4	......	0.2	1.8	2.0	....	11.0	1.85	......	0.5
Grinding feed	1	......	0.1	0.7	0.7	....	15.7	3.86	......	0.2
Running cider mill	1	......	1.2	11.0	12.2	....	12.1	1.83	......	3.1
Total belt work, custom	7	......	1.5	13.9	15.3	....	12.2	1.95	......	3.9
Total belt work	32	......	4.1	......	40.4	....	12.4	$2.26	......	10.3
Total home work	40	......	343.6	1.8	366.1	....	16.2	$3.02	......	93.8
Total custom work	14	......	7.5	13.8	24.4	....	12.7	2.27	......	6.2
Total work	41	......	351.1	15.6	390.5	....	16.0	2.97	......	100.0

of the total work. Belt work, both at home and for others, was important, 39 of the owners reporting some kind of belt work. About half of the farmers used their tractors for filling the silo and for threshing at home. The total hours of belt work at home averaged 45.2 hours per farm, or nearly 10 per cent of the total work. Nearly half of the farmers used their tractors to a greater or less extent for custom threshing and silo filling, while a few reported other kinds of custom belt work. The total hours of custom belt work averaged 115.8 per farm, or about 25 per cent of the total tractor work. About two-thirds of the total tractor work in this region was drawbar work, the other third being belt work. Nearly 70 per cent of the total tractor work was done at home, either drawbar or belt work, while about 30 per cent was custom, most of which was belt work.

In the fruit region, plowing and fitting for field crops were not so important as in the general farming region, constituting but one-third of the total hours of tractor work. Here tractors are purchased principally for orchard cultivation. When a tractor is used for orchard work, the land is not ordinarily plowed, the plow being replaced by the tractor disk. In the spring, for the first few times over the orchards, a tractor disk is used to break up the soil and destroy weeds and grass. After the soil is thoroughly pulverized, a spring-tooth harrow is usually substituted and cultivation is continued every week up to about the middle of July. With a considerable acreage of fruit, this work will keep a tractor reasonably busy during the spring and early summer. Orchard work constituted nearly half of the total tractor work on these farms. Tractors were not used to any extent for other field work. One farmer used his tractor on the manure spreader part of the time, another used his tractor to pull a potato digger, and one used his tractor to haul the spray rig when putting on the dormant spray. The advantage of the tractor when putting on the dormant spray was that the tractor could be run slowly in low gear, avoiding the necessity of stopping frequently. In other spraying, horses were used. Plowing and fitting for field crops and orchard cultivation together made up about 82 per cent, and the total drawbar work at home, 87.4 per cent, of the total tractor work. Custom work was not so important in this region. Custom belt work made up only 3.9 per cent of the total work in this region, as compared with 25.4 per cent in the general farming region. A large part of the custom belt work done in the fruit region was the work of one tractor running a cider mill. Filling silo and threshing are much less important here. The small amount of such work to be done on most farms does not justify investment in threshing and silo-filling outfits by individual farmers, except for custom work. In this region only one-tenth of the total work was belt work, as compared with more than a third in the general farming region. Home work, both

drawbar and belt, constituted 93.8 per cent of the total tractor work in this region, leaving only 6.2 per cent of custom work, as compared with 30.6 per cent for the general farming region. Although the average number of hours of drawbar work per farm in the fruit region was greater than for the general farming region, the total hours of tractor work per farm was less because less belt work was done.

The work done by tractors on 132 farms whose owners sent in complete answers to questionnaires (table 23) compares closely with the results

TABLE 23. KINDS OF WORK DONE BY TRACTORS ON 132 FARMS IN VARIOUS COUNTIES

	Number of farms reporting	Average per farm, all farms			Acres per 10-hour day	Per cent of total hours of tractor work
		Acres	Tractor hours	Average size of tool used		
Drawbar work, home:						
Plowing	128	41.9	86.0	2 1–13.5″	4.9	25.7
Harrowing	115	126.8	54.2	10.9′	23.4	16.2
Disking (double)	77	63.5	37.6	7.8′	16.9	11.3
Pulling manure spreader	14		7.2	5.5′		2.2
Binding	27	6.0	4.9	6′	12.2	1.5
Loading hay	13		4.1	8.5′		1.2
Pulling brush, trees, etc.	12		3.2			1.0
Hauling	15		2.8			0.8
Spraying	2		1.6			0.5
Mowing	6	1.4	1.0	5.5′	14.0	0.3
Unloading hay	3		0.8			0.2
Drilling	5	0.8	0.7	6.8′	11.4	0.2
Rolling	2	0.8	0.4	9.5′	20.0	0.1
Pulling ditching machine	1		0.2			0.1
Excavating with scoop	1		0.2			0.1
Cultivating	1	0.2	0.2		10.0	0.1
Digging potatoes	2	0.1	0.2		5.0	0.1
Pulling corn binder	1	0.04	0.1		4.0	0
Smoothing	1	0.2	0.1		20.0	0
Scraping roads	2		0.02			0
Total drawbar work, home	131		205.5			61.5
Drawbar work, custom:						
Plowing	39	6.8	11.3	2–13.8″	6.0	3.4
Harrowing	42	12.5	6.5	9.8′	18.9	1.9
Disking (double)	10	4.1	2.5	7.6′	16.4	0.7
Scraping roads	5		1.8			0.5
Pulling stumps, etc.	2		0.3			0.1
Binding	2	0.3	0.2		15.0	0.1
Hauling	2		0.2			0.1
Cultivating	1	0.3	0.2	6′	15.0	0.1
Opening snowed-in roads	1	0.1	0.2		5.0	0.1
Ditching	1	0.9	0.1		90.0	0
Drilling	1	0.1	0.1	6.7′	10.0	0
Digging potatoes	1	0.03	0.02		1.5	0
Total drawbar work, custom	59		23.4			7.0
Total drawbar work	132		228.9			68.5
Belt work, home:						
Filling silo	72		14.7			4.4
Sawing wood	79		12.0			3.6
Grinding feed	24		6.9			2.1
Threshing	37		6.5			1.9
Shredding and husking corn	9		2.0			0.6
Crushing stone	1		1.6			0.5
Baling hay	6		1.6			0.5
Running sawmill	1		1.4			0.4
Running cider mill	1		1.2			0.4
Demonstrating for owner	1		0.1			0
Hoisting hay	1		0.1			0
Turning grindstone	1		0.1			0
Other work	1		0.2			0.1
Total belt work, home	109		48.4			14.5

TABLE 23 (*concluded*)

	Number of farms reporting	Average per farm, all farms: Acres	Tractor hours	Average size of tool used	Acres per 10-hour day	Per cent of total hours of tractor work
Belt work, custom:						
Filling silo	57	......	24 0	....	......	7.2
Threshing	18	......	24.1	....	......	7.2
Sawing wood	26	......	8.0	......	....	2.4
Grinding feed	3	......	0 5	......	....	0.1
Baling hay	1	......	0.1	......	....	0
Total belt work, custom	73	......	56.7	....	......	17.0
Total belt work	112	.....	105 1	...	......	31.5
Total home work	132	......	253.9	......	......	76 0
Total custom work	90	......	80.1	......	......	24.0
Total work	132	......	334 0	......	......	100.0

of the general farming region given in table 21 and previously discussed. The average hours of all work per tractor are considerably lower. Probably one reason for this is that the farms visited were in regions where the crop area per farm is large. Approximately two-thirds of the total work was drawbar work and one-third was belt work. A little more than 60 per cent of the total work was drawbar work at home. On these farms, belt work at home constituted a somewhat larger proportion, and custom belt work a somewhat smaller proportion, of the total than in Cayuga County.

On the 219 farms for which this information was obtained, tractors were used by a large majority of the farmers for plowing, harrowing, and disking (table 24). They were used also by a small proportion of the farmers for pulling grain binders, hay loaders, and manure spreaders, and

TABLE 24. NUMBER AND PROPORTION OF TRACTOR OWNERS WHO USED TRACTORS FOR VARIOUS OPERATIONS, 219 FARMS

	Number of farms reporting	Per cent of farms reporting
Drawbar work, home:		
Plowing	200	91
Harrowing	186	85
Disking	148	68
Binding	36	16
Loading hay	24	11
Hauling	20	9
Pulling manure spreader	16	7
Mowing	7	3
Drilling	6	3
Unloading hay and grain	4	2
Digging potatoes	3	1

TABLE 24 (*concluded*)

	Number of farms reporting	Per cent of farms reporting
Pulling corn binder	3	1
Rolling	3	1
Spraying	3	1
Cultivating	1	0.5
Raking	1	0.5
Smoothing	1	0.5
Pulling brush, trees, etc.	22	10
Moving buildings	4	2
Excavating with scoop	1	0.5
Pulling ditching machine	1	0.5
Total home drawbar work	217	99
Total custom drawbar work	92	42
Total drawbar work	218	100
Belt work, home:		
Sawing wood	138	63
Filling silo	109	50
Threshing	61	28
Grinding feed	54	25
Shredding and husking corn	18	8
Baling hay	6	3
Running cider mill	1	0.5
Demonstrating for owner	1	0.5
Hoisting hay	1	0.5
Running sawmill	1	0.5
Turning grindstone	1	0.5
Crushing stone	1	0.5
Other work	1	0.5
Total home belt work	180	82
Total custom belt work	114	52
Total belt work	183	84
Total work	219	100

for pulling brush and trees. Only a few farmers used their tractors for other kinds of field work. More than four-fifths of all owners used their tractors for some kind of home belt work, the most frequent uses being sawing wood, filling the silo, threshing, and grinding feed. Most of this work comes when field work is not pressing and helps to increase the number of hours of tractor work annually.

About two-fifths of these tractor owners used their tractors for custom drawbar work, and slightly more than half used them for custom belt work. Apparently many farmers find that their farms are too small to keep their tractors profitably employed throughout the working season, and are able to do custom work in addition to the work on their own farms.

PROPORTIONS OF VARIOUS KINDS OF HOME DRAWBAR WORK DONE BY TRACTORS

The proportions of various kinds of home drawbar work done by tractors on all farms for which these data were obtained are given in table 25. About two-thirds of the plowing, four-fifths of the harrowing, and practically all of the disking on these farms was done by the tractors. In the general farming region, where plowing formed a considerable part of the field work, more than 90 per cent of the plowing was done by tractors, while in the fruit region only a little more than a third was so done. The general attitude in the latter region was that, since horses must be kept and since the acreage to be plowed was not large, it was cheaper to let the horses do most of the plowing. A considerable number of farmers in this region did not own tractor plows (table 32, page 101). In addition to plowing, harrowing, and disking, about 12 per cent of the binding, 9 per cent of the hay loading, 4 per cent of the manure spreading, and smaller proportions of mowing, drilling, cultivating, and other work, were done with tractors on these farms. Measured in terms of horse hours that would be required to do the work, in the general farming region the tractors did about one-half of the total drawbar work on crops (including all operations), while in the fruit region the tractors did somewhat more than one-half of this total. In both regions practically all drawbar work other than on crops was done by horses.

TABLE 25. PROPORTIONS OF VARIOUS KINDS OF HOME DRAWBAR WORK DONE BY TRACTORS ON 217 FARMS

	Number of farmers using tractors for operation	Number of farmers using horses for operation	Acres or loads per farm of each kind of work done by			Per cent of total of each kind of work done by tractor
			Tractor	Horses	Total	
Plowing (acres)	200	188	43.0	22.4	65.4	65.7
Harrowing (acres)	186	150	172.3	45.4	217.7	79.1
Disking (acres)	148	30	92.3	2.2	94.5	97.7
Binding grain (acres)	36	188	5.4	39.0	44.4	12.2
Loading hay (loads)	18	118	2.9	29.9	32.8	8.8
Pulling manure spreader (loads)	16	182	7.6	171.4	179.0	4.2
Mowing (acres)	7	212	0.9	45.2	46.1	2.0
Drilling and planting (acres)	6	212	0.6	53.1	53.7	1.1
Pulling corn binder (acres)	3	75	0.1	3.7	3.8	2.6
Rolling (acres)	3	80	0.6	39.9	40.5	1.5
Cultivating (acres)	1	210	0.1	55.6	55.7	0.2
Raking (acres)	1	217	0.2	60.0	60.2	0.3
Digging potatoes	3	Not reported	...	...		...
Spraying	3	Not reported	...	...		...
Pulling trees, rocks, etc.	22	0	...	...	...	...
Hauling	20	217	...	...	...	...
Moving buildings	4	0	...	...	...	...
Scraping roads	2	0	...	...	...	...
Unloading hay	2	215	...	...		...
Pulling ditching machine	1	0	...	...	...	...

In addition to a record of the work actually done on these farms by tractors and by horses, each farmer was asked for what operations he preferred his tractor and for what operations he preferred horses. A large majority of those who answered this question preferred a tractor for plowing, harrowing, and disking. A considerable number of tractor owners preferred a tractor for binding and for loading hay, but more than two-thirds of those reporting preferred horses for these operations. For other field work — mowing, cultivating, raking, drilling, spreading manure, and general hauling — horses were nearly a unanimous choice.

These results indicate that, in general, these New York tractor owners consider the use of tractors profitable for plowing, fitting, orchard cultivation, and other heavy drawbar work, but consider horses more economical for the light, rapid, field operations. In table 26, data are given regarding the number of horses that would be required to do the same amount of

TABLE 26. TRACTOR USE, AND EFFICIENCY OF MAN AND HORSE LABOR, IN VARIOUS OPERATIONS

Operation	Acres or loads per 10 hours of man labor when using		Horse equivalent of tractor	Man hours per acre or load saved or lost by using tractor	
	Horses	Tractor		Saved	Lost
	(Acres)	(Acres)			
Disking (double)	8.9	16.7	8.9	1.6	....
Plowing	1.7	4.8	7.3	3.7	....
Harrowing	12.3	23.0	5.8	0.4	....
Binding grain	10.6	8.1	4.7	....	0.3
Rolling	17.8	40.0	4.6	0.3	....
Drilling	10 2	10.0	3.9	0	0
Binding corn	5.2	3.2	3.8	....	1.1
Digging potatoes	3.1	4.0	3.8	0.7	....
Mowing	10.5	14.7	2.8	0.3	....
	(Loads)	(Loads)			
Loading hay	19.1	17.7	2.5	....	0.05
Spreading manure	13 5	10.9	3.7	....	....

work in a day as the average tractor in different operations on these farms. It will be seen that the operations for which tractors are largely used are, in general, those in which the tractor replaces the largest number of horses and at the same time saves man labor. In plowing and fitting, the tractors on these farms accomplished as much, on the average, as from six to nine horses. The amount of man labor saved when a tractor is used depends on the number of horses driven per man and the size of horse-drawn tools used. On these farms, walking plows and two- or three-section harrows were usually used with horses, and the saving in man labor with tractor tools was therefore considerable. In order to

replace an equal number of horses in other operations, a tractor would have to pull a 15- to 18-foot mower, or a 27- to 33-drill, or a two-row corn binder, or a 12- to 16-foot grain binder, or would have to pull narrower tools much faster than horses can. Such tools are not practicable. Tractor mowers, drills, and binders require large, level fields for efficient use. Most tractors require an extra man for mowing, binding, drilling, and loading hay, and waste labor instead of saving it. Although more acres of grain, hay, and corn were cut or drilled per day with a tractor than with horses on these farms, an extra man was usually required when a tractor was used, and the acres per 10 hours of man labor are therefore only one-half the acres covered with the tractor. As a result, fewer acres were covered for each 10 hours of man labor in binding grain and cutting corn with a tractor, than with horses, and labor was lost instead of saved. In drilling and in loading hay, enough more work was done so that the amount of work accomplished for each 10 hours of man labor was practically the same whether horses or tractors were used. In the case of hay loading, an important advantage of horses is that on many farms the team is driven by a child. When a tractor is used for loading hay, the tractor must usually be unhitched and a team put on to draw the load of hay to the barn. The only advantage of the tractor for this operation is that it can be operated at a slow, steady speed. In binding and mowing, part of the time that a tractor saves in cutting is lost in the greater amount of time and trouble involved in turning at the corners. On one farm the tractor was used in pulling up the horse fork. It is certainly doubtful economy to use a tractor and a trained operator to do work that could be done as rapidly and as well by a boy with a team or by a small engine and drum without an operator.

The average cost of operation of a tractor, without an operator, on these farms, in 1919, was $1.16 an hour (table 6, page 64). The average cost of horse labor per hour on some New York farms keeping complete cost accounts, in 1919, was about 24 cents. At these rates the cost per hour of a tractor was equivalent to the cost of 4.8 horses for one hour. On this basis the tractor was a cheaper source of power at those operations at which it did the work of more than 4.8 horses, and was a more expensive source of power when it did the work of less than 4.8 horses. This considers only the power cost of the two sources of power, and does not include the cost of machines or drivers in either case. On many farms the question of driving more horses per man is more important than the substitution of mechanical power for horse power.

In addition to these considerations, in deciding whether to use horses or a tractor for any operation, it must be remembered that it is good business to keep some horses on most New York farms, and therefore, if enough

horses are available to do the work, it is doubtful economy to use a tractor unless the saving in time is important or the quality of the tractor work is much better. If horses are available and are not working, the only extra cost when they are working is the extra feed and care required. It is a question, therefore, of the extra cost of tractor and operator (fuel, oil, repairs, and operator) as compared with the extra cost of horses and drivers.

CUSTOM WORK

Of 46 tractor owners in the general farming region of Cayuga County who were visited, 40 used their tractors to a greater or less extent for custom work. In the fruit region, 14 out of 41 did some custom work. On 132 farms for which data were obtained by the questionnaire method, 90 used their tractors to some extent for custom work. These figures are another expression of the fact that a tractor can do more work than there is to be done on most New York farms. Under such conditions, where fair pay can be secured for custom tractor work, it is often advisable to use this means of keeping the tractor profitably employed, and thus help in reducing the cost per hour of operation.

On 16 farms in the regions visited, the cash receipts for custom plowing were obtained. The rate of pay was usually by the hour and ranged from less than $1 to $3 an hour, averaging $1.95. The average cost of tractor and operator on these same farms was $1.71 an hour. Adding to this the average cost of a two-bottom tractor plow, 36 cents an hour, would give a total cost of $2.07 for the outfit. The small loss resulting because these tractor owners received slightly less per hour for the use of their tractor outfits in plowing than the average cost per hour, does not mean that they should discontinue custom work. If a tractor is owned and there is no more profitable work to be done on the operator's own farm, it is better to use the machine for custom work as long as enough can be earned to more than pay the extra costs entailed by the extra work — the operator's time, fuel, oil, and repairs. The most effective way of decreasing the cost per hour of tractor operation is to keep the tractor busy at profitable work. On the farms visited, the owners using their tractors for custom work as well as for home work were able to keep them profitably employed more hours in the year, and hence secured a lower cost per hour of tractor operation (table 27). The tractors used for custom work as well as for home work did about as much work at home as those used only for home work, and in addition were used to a considerable extent away from home.

One of the strong points usually made by tractor advocates is that tractors do not eat when they do not work. This statement is literally

TABLE 27. RELATION OF CUSTOM WORK TO KIND AND AMOUNT OF WORK DONE AND TO COST OF TRACTOR OPERATION ON 87 FARMS

	Tractors doing home work only	Tractors doing home and custom work	
		Custom work chiefly drawbar work	Custom work chiefly belt work
Number of farms reporting	33	25	29
Average acres in crops per farm in 1919	130.0	121.9	148.1
Average hours of home drawbar work per farm	307.4	360.7	251.2
Average hours of home belt work per farm	24.5	24.4	58.3
Average hours of all home work per farm	331.9	385.1	309.5
Average hours of custom drawbar work per farm	0	43.2	13.4
Average hours of custom belt work per farm	0	10.7	195.9
Average hours of all custom work per farm	0	53.9	209.3
Average hours of all work per farm	331.9	439.0	518.8
Average cost per hour of tractor without operator	$1.47	$1.29	$1.20

true in that an idle tractor consumes no fuel or oil, but it is not true that tractor costs cease when the machine is not working. In table 28, the average costs of tractor operation on the farms visited are divided into three groups, depending on their relation to the amount of tractor work done. The first group comprises costs not depending at all on the work

TABLE 28. COSTS OF TRACTOR OPERATION GROUPED ACCORDING TO THEIR RELATION TO WORK DONE, ON 87 FARMS IN CAYUGA, MONROE, AND ORLEANS COUNTIES

	Per tractor	Per hour	Per cent of total cost of tractor without operator
I. Costs not depending on work done:			
Interest	$39.72	$0.093	8.1
Use of buildings	4.82	0.011	1.0
Insurance	0.35	0.001	0.1
Total	$44.89	$0.105	9.1
II. Costs depending somewhat on work done, but not proportional to it:			
Depreciation	$187.25	$0.441	38.0
Repairs, new parts, etc	44.25	0.104	9.0
Work (other than chores) on tractor by farm labor	19.10	0.045	3.9
Automobile use	2.78	0.007	0.6
Horse labor	0.30	0.001	0.1
Total	$253.68	$0.598	51.4

TABLE 28 (*concluded*)

	Per tractor	Per hour	Per cent of total cost of tractor without operator
III. Costs proportional to work done:			
Chores on tractor by farm labor	$ 19.84	$0.047	4.0
Lubrication	37.58	0.088	7.6
Fuel	137.38	0.323	27.8
Total	$194.80	$0.458	39.5
Total cost of tractor without operator	$493.37	$1.161	100.0

done—interest, use of buildings, and insurance. These costs continue, whether a tractor is used or not, and together they constitute about 9 per cent of the average total cost of the tractor without an operator, or $44.89 annually per tractor.

The costs in the second group depend somewhat on the amount of tractor work done, but are not proportional to it. The chief costs included in this group are depreciation and repairs. This group of costs constituted 51 per cent of the average total cost of the tractor without an operator, or $253.68 per tractor annually. Depreciation is the most important single item of cost, and, while it is somewhat heavier when a tractor is working, it continues whether the machine is working or not. Because of the newness of the farm tractor, depreciation by obsolescence is probably more rapid than depreciation by wearing out. This group of costs probably would not be decreased as much as one-half if the tractor were idle for the entire year.

The third group, costs proportional to work done, includes fuel, oil, and chores. These costs constitute slightly less than 40 per cent of the average total cost of the tractor without an operator, or $194.80 per tractor annually. They cease when work stops. The other tractor costs, more than 60 per cent of the total, do not.

It would be foolish for a tractor operator to do custom work unless he got pay for the time of the operator, all costs of the third group, and at least the extra part of the second group due to the extra work done. It would be desirable to get total cost or more, but if more profitable work were not available at home, it might be advisable to do custom work at less than the average total cost.

The relation of the amount and kind of custom work done, to the investment in tractor equipment, is shown in table 29. There is little

difference, between the groups, in the proportion of tractor owners who own tractor plows and disks. In the case of the belt tools, however, a much larger proportion of those doing custom belt work own threshers, silo-filling outfits, and corn huskers. This would indicate that the investment in such expensive tools for use only on one farm is of doubtful economy. Much of this work is done at such times of the year that it does not interfere seriously with other farm work.

TABLE 29. RELATION OF CUSTOM WORK TO INVESTMENT IN TRACTOR EQUIPMENT AND OTHER FACTORS, 216 FARMS

	Tractors doing home work only	Tractors doing home and custom work	
		Custom work chiefly drawbar work	Custom work chiefly belt work
Number of farms reporting	75	63	78
Per cent of all tractor owners owning:			
Tractor plow	91	94	97
Tractor disk	73	75	56
Wood saw	29	19	44
Ensilage cutter	24	27	46
Thresher	12	3	32
Feed grinder	12	16	18
Corn husker	1	3	9
Average value of tractor equipment per farm	$343.00	$338.00	$551.00
Average annual amount of belt work hired per farm before tractor was purchased	$89.62	$100.82	$92.19
Average annual amount of belt work hired per farm after tractor was purchased	$61.13	$65.51	$26.01
Decreased annual amount of belt work hired after tractor was purchased	$28.49	$35.31	$66.18
Per cent of owners now owning one-plow tractors	4	0	2
Per cent of owners now owning two-plow tractors	84	89	77
Per cent of owners now owning three-plow tractors	12	11	21

The average investment in tractor equipment was much greater on the farms doing custom belt work. In addition to the money received for custom work, these men decreased the annual cash outlay for belt work on their own farms about $66 a farm as compared with from $28 to $35 for the other groups. The operators doing a considerable amount of custom belt work have also, in general, purchased larger tractors than the others.

TRACTOR EQUIPMENT

In deciding on the advisability of purchasing a tractor, one of the important factors to be considered is the necessary investment in tractor

equipment. In order to get the most efficient use of a tractor, it is usually necessary to have a considerable investment in tractor plows, disks, and other items of tractor equipment. Almost every tractor owner purchases a tractor plow (table 30). A large proportion of the tractor operators included in this study also owned spring-tooth harrows and tractor disks.

TABLE 30. TRACTOR EQUIPMENT ON 220 FARMS

	Number of farmers having tractor tools					Per cent of all farmers having tractor tools		
	Previously owned, now used with tractor	Purchased for use with tractor	Total owned	Borrowed, rented, or used in cooperation	Total using	Owned	Borrowed, rented, or used in cooperation	Total using
Drawbar tools:								
Tractor plow	0	207	207	4	211	94	2	96
Spring-tooth harrow	162	24	186	0	186	85	0	85
Tractor disk	20	132	152	6	158	69	3	72
Tractor mower	0	1	1	0	1	0.5	0	0.5
Cultipacker	1	4	5	0	5	2	0	2
Tractor drill	0	1	1	0	1	0.5	0	0.5
Belt tools:								
Wood saw	55	38	93	37	130	42	17	59
Ensilage cutter	28	57	85	24	109	39	11	50
Thresher	9	33	42	22	64	19	10	29
Feed grinder	19	21	40	3	43	18	1	20
Hay press	2	2	4	2	6	2	1	3
Corn husker	5	7	12	0	12	5	0	5
Sawmill	1	0	1	0	1	0.5	0	0.5
Stone crusher	1	0	1	0	1	0.5	0	0.5
Miscellaneous:								
Tanks, drums, and cans	78	142	220	0	220	100	0	100
Machine tools	1	26	27	0	27	12	0	12
Service wagon	6	7	13	0	13	6	0	6

Most of the spring-tooth harrows were horse harrows to which one or more sections had been added. In a few cases, horse disks were used with tractors, but they are not heavy enough to stand tractor usage satisfactorily. Even with heavy tractor tools built especially for use with tractors, the average estimate of these owners indicated that depreciation was about 25 per cent faster on tractor tools than on horse tools used with horses. About two-fifths of all tractor owners owned buzz saws and ensilage cutters, and about one-fifth owned threshers and feed grinders. In addition to the machines owned, a considerable number of tractor owners borrow or rent the larger belt machines, such as threshers and silo-filling outfits, or cooperate with a neighbor who owns such machines but no tractor. Cooperative ownership of threshers and silo-filling outfits by groups of neighboring farmers seems to be increasing in regions where such work is important, and is apparently giving good satisfaction. Usually one or more members of the cooperating group own tractors which are rented at a reasonable rate to cooperators not owning them.

The average investment in tractor equipment was slightly more than $500 a farm for all farms included in table 30. This includes only equipment actually owned and used chiefly with tractors. In the few cases in which threshers or other belt tools were owned but were used with other engines instead of with the tractor, the value of such tools has not been included as investment in tractor equipment. In addition to the tractor tools given and included in this investment, ordinary farm tools, such as manure spreaders, mowers, hay loaders, binders, and drills, were used with tractors to a small extent on some farms (table 24, page 90).

The kinds of tractor equipment that it will pay to purchase on any farm depend on the size of farm, the type of farming, the capital available, and other factors. In the general farming region of Cayuga County, every tractor owner had a tractor plow, while in the fruit region only 80 per cent of the tractor owners had tractor plows (tables 31 and 32). In the latter region, plowing is less important and a large proportion of it is done with horses. For spring-tooth harrows and disks, these proportions were nearly reversed in these two regions. In the fruit region, the

TABLE 31. TRACTOR EQUIPMENT ON 46 FARMS IN CAYUGA COUNTY, A GENERAL FARMING REGION

	Number of farmers having tractor tools					Per cent of all farmers having tractor tools			Average cost per tractor, all farms
	Previously owned, now used with tractor	Purchased for use with tractor	Total owned	Borrowed, rented, or used in cooperation	Total using	Owned	Borrowed, rented, or used in cooperation	Total using	
Drawbar tools:									
Tractor plow	......	46	46	0	46	100	0	100	$166.98
Spring-tooth harrow	33	6	39	0	39	85	0	85	30.17
Tractor disk	12	26	38	0	38	83	0	83	90.63
Cultipacker	1	1	2	0	2	4	0	4	3.70
Total drawbar tools	......	......	.....	....	.....	....	....	.....	$297.18
Belt tools:									
Wood saw	14	2	16	13	29	35	28	63	$6.67
Ensilage cutter	8	5	13	8	21	28	17	46	34.76
Thresher	3	9	12	11	23	26	24	50	92.78
Feed grinder	8	12	20	1	21	43	2	46	22.08
Corn husker	4	4	8	2	10	17	4	22	20.15
Hay press	1	1	2	0	2	4	0	4	15.44
Total belt tools	......	......	.....	....	.....	.....	....	.....	$101.88
Miscellaneous:									
Tanks, drums, etc.	3	43	46	0	46	100	0	100	$18.36
Machine tools	1	8	9	0	9	20	0	20	3.15
Service wagon	2	2	4	0	4	9	0	9	1.72
Total miscellaneous	......	......	.....	....	.....	.....	....	.....	$23.23
Total equipment	......	....	.....	....	.....	.....	....	.....	$512.59

TABLE 32. TRACTOR EQUIPMENT ON 41 FARMS IN MONROE AND ORLEANS COUNTIES, A FRUIT REGION

	Number of farmers having tractor tools					Per cent of all farmers having tractor tools			Average cost per tractor, all farms
	Previously owned, now used with tractor	Purchased for use with tractor	Total owned	Borrowed, rented, or used in cooperation	Total using	Owned	Borrowed, rented, or used in cooperation	Total using	
Drawbar tools:									
Tractor plow	....	33	33	2	35	80	5	85	$93.54
Spring-tooth harrow	31	8	39	0	39	95	0	95	39.41
Tractor disk	3	34	37	2	39	90	5	95	82.09
Cultipacker	0	2	2	0	2	5	0	5	5.07
Orchard harrow	1	1	2	0	2	5	0	5	2.44
Total drawbar tools	......	....	.....	....	....	.....	......	.....	$222.55
Belt tools:									
Wood saw	16	6	22	11	33	54	27	80	$11.34
Ensilage cutter	5	7	12	2	14	29	5	34	31.25
Thresher	0	1	1	0	1	2	0	2	5.49
Feed grinder	4	8	12	0	12	29	0	29	10.21
Total belt tools	.....	..	....	.....	....	...	....	....	$58.29
Miscellaneous:									
Tanks, drums, etc.	2	39	41	0	41	100	0	100	$21.46
Machine tools	0	9	9	0	9	22	0	22	1.85
Service wagon	3	1	4	0	4	10	0	10	2.56
Total miscellaneous	....	..	..	.....	..	..	....	.	$25.87
Total equipment	....	.....	....	....	.....	..	...	.....	$306.71

most important tractor work is orchard cultivation and practically every farmer used both a spring-tooth harrow and a disk in this work. A larger proportion of the farmers in the general farming region own threshers, silo-filling outfits, and other belt-power machines which are used with tractors. The average total investment per farm in all tractor equipment in the general farming region was much larger than in the fruit region, due principally to the greater average investment in belt-power machines. From 15 to 20 per cent of the total investment in tractor equipment per farm was for tools previously owned but now used chiefly with the tractor.

The average costs for each of the various items of tractor equipment purchased for use with tractors are given in table 33. The average costs here given include some machines purchased second-hand and some purchased at lower price levels than those prevailing in 1920. The actual cost of new machines would therefore be somewhat greater in most cases.

A partial offset to the extra investment in tractors and tractor equipment is furnished by the amounts realized by the sale of equipment not needed after the purchase of a tractor and the decreased outlay for belt

work. About one-fourth of these tractor owners sold one or more items of farm equipment no longer needed after the purchase of a tractor. The tools sold were chiefly horse-drawn plows and disk harrows, and gasoline engines formerly used for belt power. The average receipts per farm for all farms from this source amounted to $23.88. In the general farming

TABLE 33. AVERAGE COST OF TRACTOR EQUIPMENT

	Number of tools	Average size	Average cost
Drawbar tools:			
Tractor plow	207	2.2–13.5″	$152.72
Spring-tooth harrow	24	9.4′	58.79
Tractor disk	132	7.9′	118.25
Tractor mower	1	8′	130.00
Cultipacker	4	....	95.75
Tractor drill	1	....	215.00
Belt tools:			
Wood saw	38	....	32.45
Ensilage cutter	57	14.8″	198.04
Thresher	33	....	451.00
Feed grinder	20	....	54.95
Hay press	2	....	697.50
Corn husker and shredder	7	....	147.14
Miscellaneous:			
Tanks, drums, cans, etc	142	....	22.85
Machine tools	26	....	14.46
Service wagon	7	....	26.00

region the average cash outlay for belt work decreased $59.30 per farm, and in the fruit region $22.04 per farm (tables 34 and 35). This decreased outlay was estimated on the basis of 1919 costs for threshing, silo filling, and other belt work. It is not clear gain, as the extra equipment involved interest, repairs, and upkeep costs and the cost for use of tractor. More farm labor is necessary for doing one's own belt work, as from two to four men are usually furnished when this work is hired; but the work can usually be arranged at a more convenient time, and by cooperating with neighbors less labor need be hired.

EFFECTS OF USE OF TRACTORS ON FARM ORGANIZATION

Of the 87 farmers in the general farming and fruit regions who were visited, 17, or about 20 per cent, increased the size of their farms after purchasing tractors; 4 or 5 per cent decreased the size of their farms; and the remainder made no change in their farm area. The average increase in size of farms was 16.8 acres per farm for all farms, or 13.1 acres of crops, in the general farming region (table 34); and 11.9 acres per farm, or 7.2 acres of crops, in the fruit region (table 35). In the general

farming region the average number of productive man-work units[2] per farm was increased 8.4 per cent and the number of productive horse-work units 9.7 per cent. Of the farms in various parts of the State for which information was obtained by questionnaires, about 14 per cent increased the size of their farms after purchasing tractors, 1 per cent decreased the size of their farms, and the remainder made no changes in total farm area. The average increase in total area for all farms reporting was 7.4 acres per farm. About two-thirds of these farms increased the area of crops, the average increase for all farms being 13.1 acres. Since the average increase in crop area is greater than the average increase in total area, it is evident that the use of a tractor enabled the owners to use for crop production some land that had hitherto been devoted to pasture or other purposes.

RELATION OF USE OF TRACTOR TO MAN AND HORSE LABOR

In spite of the increased area of crops grown, an average of 1.6 less horses per farm were kept in the general farming region and 1.8 less horses per farm in the fruit region (tables 34 and 35). The amount of grain and hay fed to horses also was reduced. An average of from 552 to 762 less

TABLE 34. RELATION OF TRACTOR USE TO MAN AND HORSE LABOR AND OTHER FACTORS ON 46 FARMS IN CAYUGA COUNTY, A GENERAL FARMING REGION

	Year before purchase of tractor	In 1919 after purchase of tractor	Gain or saving, or loss
Total acres per farm	199.7	216.5	16.8
Total acres of land in crops per farm	140.8	153.9	13.1
Horses per farm	6.1	4.5	1.6
Grain fed to horses per farm per year (pounds)	20,245	11,506	8,739
Grain fed per horse per year (pounds)	3,319	2,557	762
Hay fed to horses per farm per year (pounds)	45,104	31,978	13,126
Hay fed per horse per year (pounds)	7,394	7,106	288
Average value of horses	$174.50	$165.70	....
Average weight of horses (pounds)	1,245	1,228	....
Estimated total useful life of horses (years)	11.9	14.2	....
Average months of hired labor per farm per year	13.4	9.9	3.5
Average months of unpaid labor per farm per year	3.4	4.3	—0.9
Average months of all labor except operator per farm per year	16.8	14.2	2.6
Average number of men employed per farm per year	2.4	2.2	0.2
Crop acres per man	58.7	70.0	11.3
Crop acres per horse	23.1	34.2	11.1
Average size of crop fields	12.3	13.3	....
Cost of belt work hired per farm per year	$134.50	$75.20	$59.3
Average depth plowed (inches)	6.7	7.5	....

[2] A productive work unit is the average amount of productive work accomplished in a 10-hour day.

TABLE 35. RELATION OF TRACTOR USE TO MAN AND HORSE LABOR AND OTHER FACTORS ON 41 FARMS IN MONROE AND ORLEANS COUNTIES, A FRUIT REGION

	Year before purchase of tractor	In 1919 after purchase of tractor	Gain or saving
Total acres per farm	135.8	147.7	11.9
Total acres of land in crops per farm	112.2	119.4	7.2
Horses per farm	6.4	4.6	1.8
Grain fed to horses per farm per year (pounds)	19,947	11,797	8,150
Grain fed per horse per year (pounds)	3,117	2,565	552
Hay fed to horses per farm per year (pounds)	41,817	29,342	12,47
Hay fed per horse per year (pounds)	6,534	6,379	155
Average value of horses	$221.00	$215.00	....
Average weight of horses (pounds)	1,316	1,304	....
Estimated total useful life of horses (years)	12.4	14.6	2.2
Average months of hired labor per farm per year	19.6	17.5	2.1
Average months of unpaid labor per farm per year	2.9	2.9	....
Average months of all labor except operator per farm per year	22.5	20.4	2.1
Average number of men employed per farm per year	2.9	2.7	0.2
Crop acres per man	38.7	44.2	5.5
Crop acres per horse	17.5	26.0	8.5
Average size of crop fields	11.9	12.2	....
Cost of belt work hired per farm per year	$80.02	$57.98	$22.04
Average depth plowed (inches)	6.2	6.8	....

pounds of grain were fed per horse when tractors were used on these farms, due largely, the farmers said, to the fact that the tractor did a large part of the heaviest work, plowing and fitting. While this saving in grain per horse was largely due to the use of a tractor, it is probable that high prices of grain in 1919 had some effect in encouraging economy of horse feed. Practically the same amount of hay was fed per horse, the saving of hay being due to the smaller number of horses kept. A few farmers saved some hay by pasturing horses more when the tractor was used. The horses kept averaged slightly lighter in weight and were somewhat cheaper animals. While some farmers kept as good horses as before, others reported that with a tractor to take the heaviest burden of work, they were able to get along with older, cheaper horses which could stand hard work for a short period. Most farmers believed that the useful life of horses would be somewhat increased by the use of a tractor, the estimated average increase being about two years.

After the purchase of a tractor, about 25 per cent less labor was hired on the farms in the general farming region and about 10 per cent less in the fruit region (tables 34 and 35). Transient labor for picking fruit is not included in the figures given, as the amount of such labor would not be affected by the use of a tractor. The decrease in labor hired in

the general farming region was partly offset by an increase of nearly one month per farm of unpaid labor by members of the farmer's family. The crop areas per man and per horse were also increased in both regions. The smaller number of acres of crops per man and per horse in the fruit region is due to the more intensive crops grown. Owing to the unusual conditions brought about by the war, it is impossible to determine just how many of these changes are due to the use of tractors. The average crop acres per man on all farms were increased during the war. High prices and shortage of labor caused other changes.

Perhaps the best measure of the amount of man and horse labor saved by the use of a tractor was obtained by asking the farmers to give the number of horses and the months of labor needed on their present farms both with and without a tractor. This avoids the variation caused by changes in the size of farms and in labor conditions since the tractor was purchased. The answers to these questions are shown in table 36. Although these savings are somewhat greater than the actual savings

TABLE 36. RELATION OF USE OF TRACTOR TO MAN AND HORSE LABOR, 220 FARMS

	In addition to tractor	Without tractor	Saving by use of tractor
Estimated number of horses needed per farm on present farms	3.9	6.3	2.4
Estimated months of hired labor needed per farm on present farms	13.2	17.3	4.1

made as shown in tables 34 and 35, it should be remembered that the actual savings indicated in those tables have been made in addition to raising more crops per farm. With corrections for the amount of labor necessary to take care of the increased crop, the results check closely with those in tables 34 and 35.

The statement was made by some of the tractor owners visited that the saving in horse feed effected by the tractor was enough to pay for the fuel and oil used. If the grain feed is counted to be worth $2.50 a hundred pounds, and hay $20 a ton, the feed saved annually amounted to $349.73 per farm in Cayuga County and $328.50 per farm in the fruit region, while the average cost of fuel and oil per tractor for the year was $174.96. Grain and hay have dropped in price, while fuel and oil prices have increased since 1919. With grain at $1.50 a hundred pounds and hay at $15 a ton, the feed saved annually would amount to about $230

per farm in Cayuga County and about $216 in the fruit region. At January, 1921, prices, the cost of fuel and oil would be about $230 per tractor. In 1919, on the farms studied, the costs of fuel and oil amounted to slightly more than one-fourth of the total cost of tractor operation.

In the fruit region many farms do not raise enough grain and hay for horse feed if horses alone are depended on for power. Since there is a considerable difference between the buying and selling prices of feed, the fact that some horse feed would have to be purchased gives the tractor a greater advantage here than in regions like Cayuga County, where all the horse feed is raised.

DISTRIBUTION OF HORSE LABOR AND DISPLACEMENT OF HORSES

The number of horses that a tractor will displace on any farm depends on whether or not the tractor is able to displace horses at the time of greatest pressure of horse work. It has been previously shown (tables 24 and 25, pages 90 and 92) that, on the farms studied, tractors were used generally for the heavy operations, in which they could do the work of a considerable number of horses, but were used little for the light, rapid operations, in which a team could do about as much work in a day as a tractor. If the number of horses kept on a farm is determined by the number necessary to do the required amount of spring plowing and fitting, the greatest pressure of which usually comes in May, a tractor that will do a large part of this work efficiently should be able to displace some horses. These conditions exist on many corn-belt farms, and on some New York farms on which considerable areas of crops other than hay are grown. On many New York farms the number of horses kept is determined by the number necessary to do the work of haying, cultivating, and harvesting, the greatest pressure of which comes in July. On such farms, fewer, if any, horses can be displaced. If the same number of horses must be kept whether a tractor is used or not, the principal effect of the use of a tractor would be to decrease the amount of work done per horse annually. It is questionable economy to use a tractor for field work when the horses are standing idle, unless the saving in time is very important. The principal function of the tractor in field work on New York farms is to aid the horses in times of greatest pressure.

In figure 18 is shown the distribution of horse labor on a western New York farm in 1918 before the purchase of a tractor. The data for this and the following charts on horse-labor distribution are taken from complete farm cost accounts kept by the farmers in cooperation with the Department of Agricultural Economics and Farm Management of the

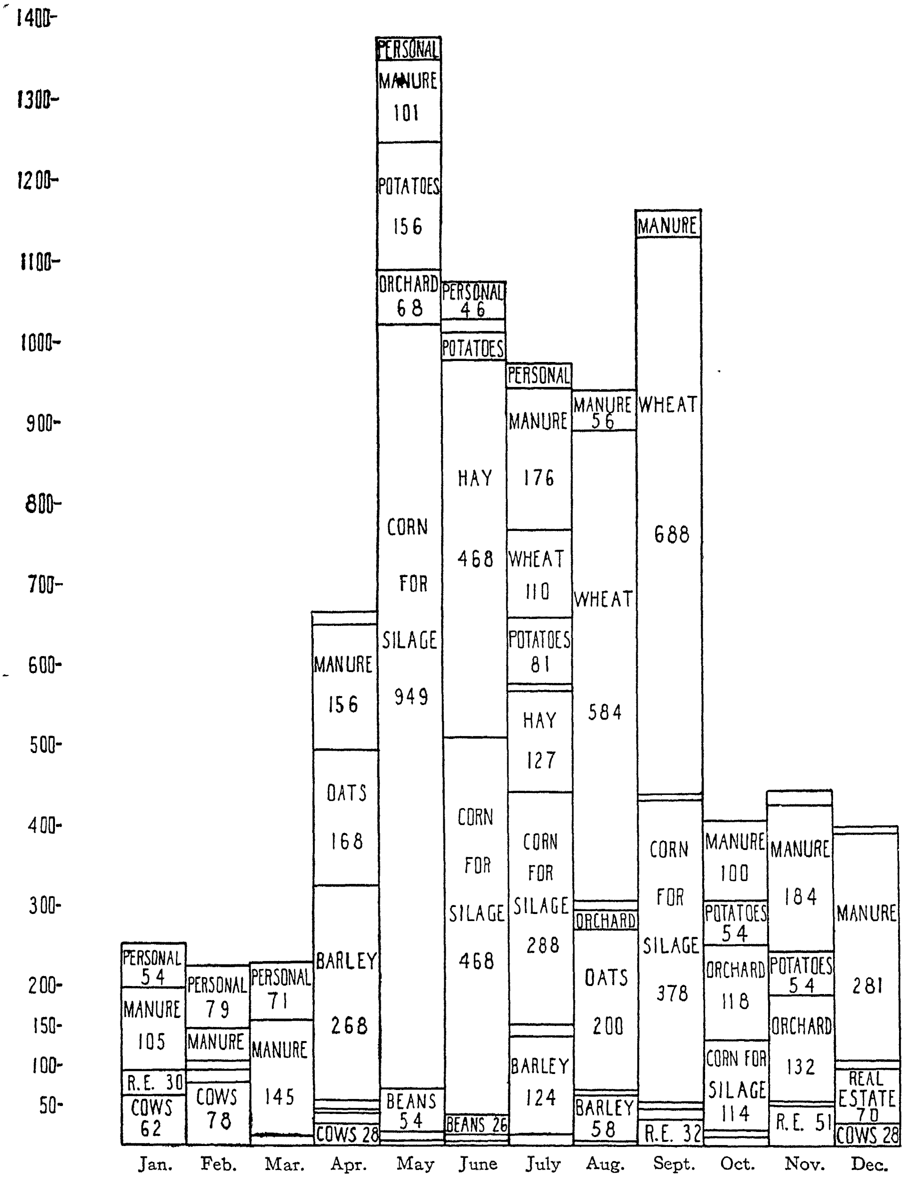


FIG. 18. DISTRIBUTION OF HORSE LABOR ON A WESTERN NEW YORK FARM IN 1918, BEFORE THE PURCHASE OF A TRACTOR

Farm area 220 acres; total crop area 167.3 acres: 57.3 acres hay, 33.4 acres wheat, 25.8 acres corn for silage, 21.1 acres oats, 15.6 acres barley, 3.4 acres potatoes, 1.4 acres beans, 9.3 acres apples. An average of 7 work horses and 32 cows were kept. The average number of hours worked per horse per working day was 3.9

New York State College of Agriculture, and the Office of Farm Management of the United States Department of Agriculture. The farm is large, the land is nearly level, and the fields are mostly of good size. The month of greatest pressure of horse labor in 1918 was May, with plowing, fitting, and planting corn the most important work. The other crops demanding work at this time were potatoes and apples. The month of next greatest pressure of horse work was September, with fitting and planting wheat the most important work. At the end of the month, cutting corn and filling the silo demanded horse labor. The other months of some pressure for horse labor were June, July, and August. In June, haying (alfalfa) and cultivating were the most important operations; in July, cultivating, haying (timothy and clover), and cutting wheat; and in August, drawing wheat, harvesting oats and barley, and plowing for wheat.

It appears that under conditions existing on this farm an efficient tractor should be able to displace some horses. The most important farm operations in two of the months of greatest pressure of horse work were plowing and fitting, operations in which the farm tractor can displace the greatest number of horses and at the same time save man labor. The farm is large enough to keep a tractor busy most of the season at profitable work, there is a considerable amount of belt work, the topography is nearly level, the land is reasonably free from stones and well drained, and the fields are large. Late in the spring of 1919 a two-plow tractor was purchased by this farmer and has been used since that time. The distribution of horse labor on this farm for the year 1920 is shown in figure 19. The use of the tractor reduced the horse labor in the months of former greatest pressure, May, September, and June. July is now the month of greatest pressure of horse work, and it is the amount of work to be done at this time that determines the number of horses to be kept. The chief operations using horses in July are haying, cultivating, and harvesting wheat, operations in which the tractor has not been very successful in displacing horses.

Partly because of the fact that the tractor was not purchased until late in the spring, and partly because of the unfavorable season, the same number of horses was kept on this farm in 1919 as in 1918, namely, seven. The total hours of horse labor on crops were reduced about 2000 hours, and as a result the average number of hours worked per horse per working day decreased from 3.9 in 1918 to 2.4 in 1919. As a partial offset to this decrease of horse efficiency, the amount of hay and grain fed to horses was reduced considerably. In 1920 the average number of horses kept was reduced to 4.25. Four horses were kept throughout the year and

an extra horse was hired in haying and potato digging. The average number of hours worked per horse per working day was 4.2. Although the farm area has not been changed and the crop area has been actually

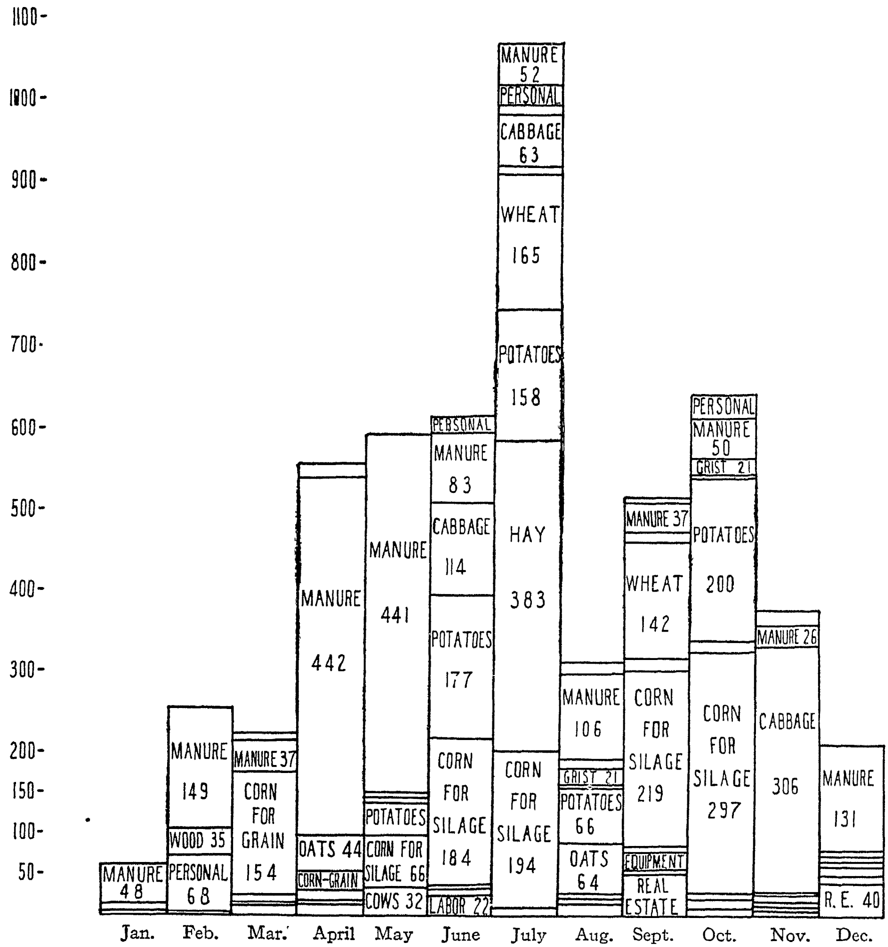


Fig 19. DISTRIBUTION OF HORSE LABOR ON A WESTERN NEW YORK FARM IN 1920, AFTER THE PURCHASE OF A TRACTOR

Farm area 220 acres; total crop area 130.3 acres: 42.6 acres hay, 28.3 acres wheat, 28 acres corn for silage, 15.9 acres oats, 8 acres cabbage, 7.5 acres potatoes. An average of 4.25 work horses and 41.6 cows were kept. The average number of hours worked per horse per working day was 4.2

reduced, this farmer has increased the area of intensive crops and so has increased the total amount of drawbar work on crops. In spite of this increase in drawbar work, fewer horses are kept. This farmer considers

that the tractor displaces two or three horses and also saves man labor. The distribution of tractor work in 1920 on this farm is shown in figure 20. The months of greatest pressure of tractor work were August, May, and September. These are the months in which the horse work was formerly high and in which the tractor has been able to displace horses.

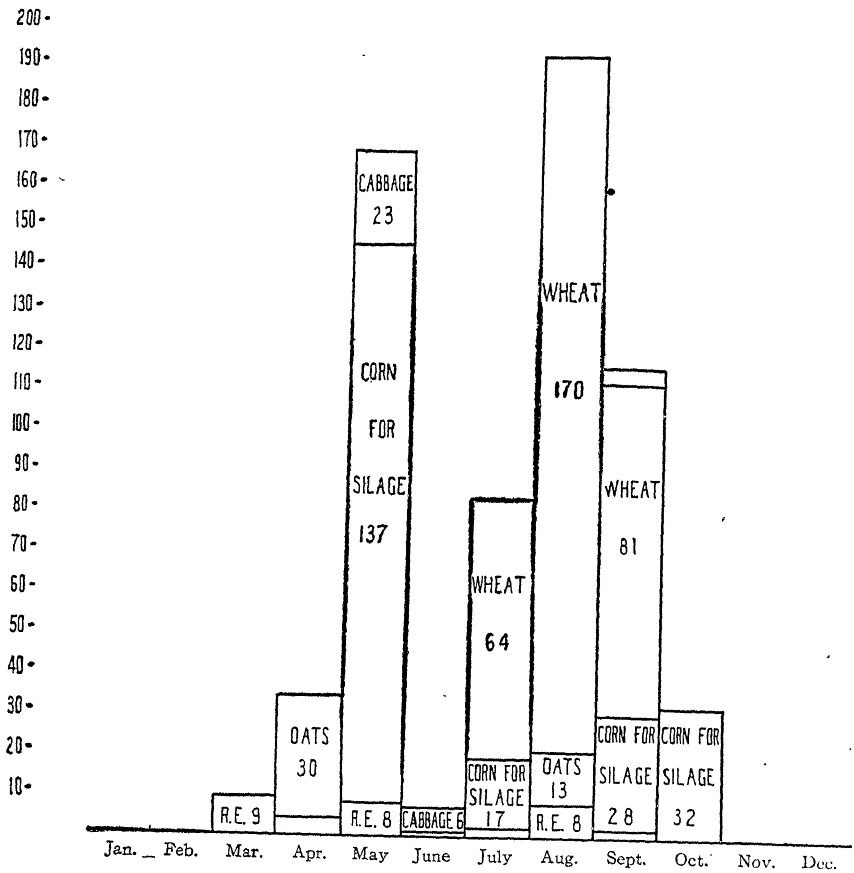


FIG. 20. DISTRIBUTION OF TRACTOR WORK IN 1920 ON THE WESTERN NEW YORK FARM REPRESENTED IN FIGURES 18 AND 19

Total tractor work for the year, 641 hours

The distribution of horse labor on a central New York farm in 1916 before the purchase of a tractor is shown in figure 21. The farm area was 162 acres. The land in most of the cultivated fields is gently rolling, the steepest slopes being kept in alfalfa. The month of greatest pressure of horse work on this farm in 1916 was August, followed by July, May,

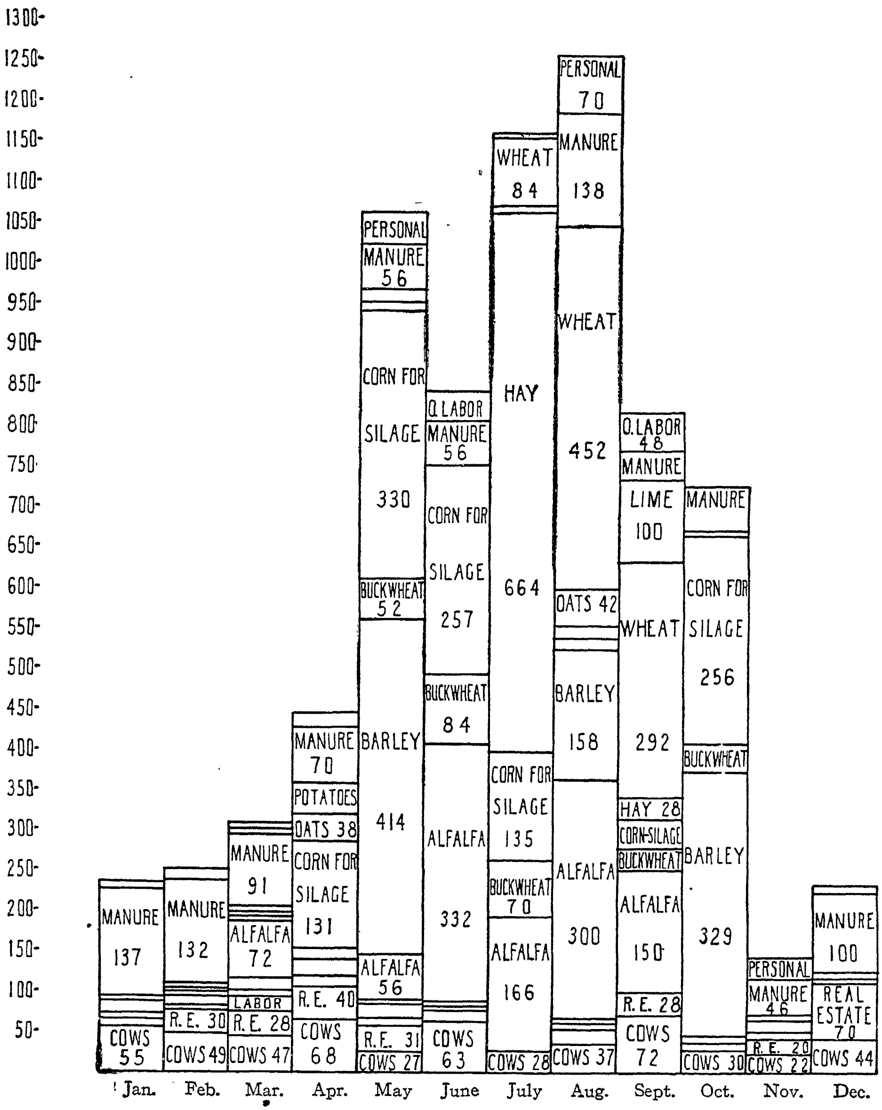


FIG. 21. DISTRIBUTION OF HORSE LABOR ON A CENTRAL NEW YORK FARM IN 1916, BEFORE THE PURCHASE OF A TRACTOR

Farm area 162 acres; total crop area, 134.4 acres: 37.1 acres alfalfa, 31 acres hay, 22.5 acres corn, 18.3 acres wheat, 12.7 acres barley, 9.8 acres buckwheat, 3 acres oats. An average of 8.7 work horses and 32 cows were kept. The average number of hours worked per horse per working day was 2.9

June, and September, in order. The most important horse operations in August were plowing and fitting for wheat, harvesting the second cutting of alfalfa, and harvesting and threshing barley and oats. In July the chief operations were haying, cultivating, putting in buckwheat, and cutting wheat. The principal work in May was plowing and fitting for and planting barley and corn, and plowing for buckwheat. The soil on this farm is so heavy that fall plowing does not give satisfactory results, and therefore this work cannot be shifted to the fall months when farm work is less pressing. In June the chief operations were fitting ground for and planting corn, plowing for buckwheat, and cutting alfalfa. In September, putting in wheat and harvesting the third cutting of alfalfa required the most horse work. In every month except July an important part of the work was made up of plowing and fitting, work in which an efficient tractor can displace a number of horses.

In 1917 this farmer purchased a tractor. In the spring of 1918 he purchased the 54-acre farm adjoining, increasing his farm area to 216 acres. In spite of the increase in farm area of 54 acres and in crop area of about 22 acres, the average number of horses kept in 1918 was 5.6, a decrease of 3.1. Apparently the farm was somewhat overstocked with horses before the tractor was purchased, and understocked in 1918. In 1919, with the farm of the same size as in 1918, six horses were kept. The total number of hours of horse work per year decreased from 7480 in 1916 to 5538 in 1918 and 5968 in 1919. The average number of hours worked per horse per working day increased from 2.9 in 1916 to 3.3 in 1918 and in 1919. August remained the month of greatest pressure of horse work (fig. 22), but in spite of the larger farm, the hours of horse work for this month were reduced from 1254 in 1916 to 1032 in 1918. Most of the plowing and the fitting for wheat formerly done by horses is now done by the tractor. The work done by horses in August consists of haying, harvesting, and threshing. Some lime was hauled from the car and some manure was spread, but this work was not fixed as to time and could have been done as well in some other month when work was less urgent. The horse labor was fairly evenly distributed through the other summer months. Both tractor and horses were employed efficiently.

The distribution of tractor labor by months on this farm is shown in figure 23. The months of greatest pressure of tractor work are those in which the horse work was formerly high and the tractor has been able to displace horses. The high month for tractor work in 1918 was May, with 113 hours, followed in order by April, August, September, and October. On this farm the tractor has been successful in displacing horses

in the busy months of May, April, August, and September. In July, a busy month for horses, the tractor was used only for improvement work on the farm. The principal kinds of tractor work are plowing, fitting,

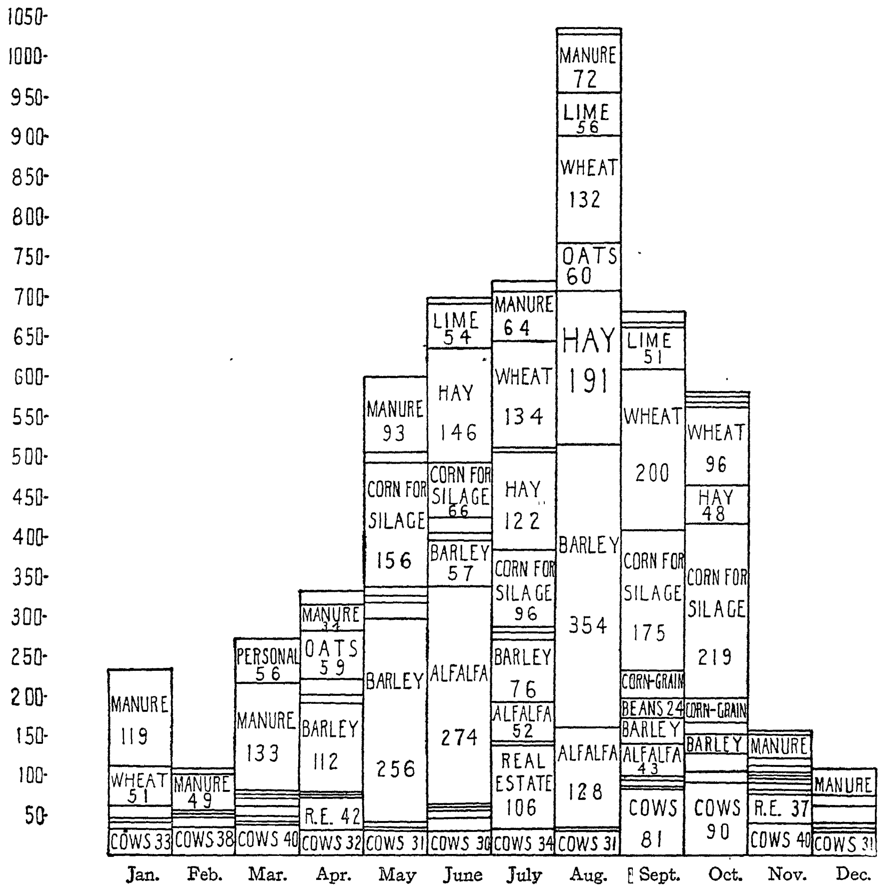


FIG. 22. DISTRIBUTION OF HORSE LABOR ON A CENTRAL NEW YORK FARM IN 1918, AFTER THE PURCHASE OF A TRACTOR

Farm area 216 acres; total crop area 156.7 acres: 23.3 acres alfalfa, 19.6 acres hay, 21.3 acres corn for silage, 32.7 acres wheat, 47.4 acres barley, 6 acres oats, 3.8 acres corn for grain, 2.6 acres beans. An average of 5.6 horses were kept; in 1919, on the same farm, 6 horses were kept. Not only was the area of crops increased since 1916, but the amount of drawbar work on crops was increased about one-fourth. The average number of hours worked per horse per working day was 3.3

threshing, and filling the silo. The tractor is not used for binding grain or corn on this farm. This is probably due partly to the fact that the tractor is of the heavy, slow type, and partly to the fact that many of

the fields are rather small. With larger fields, a lighter, faster tractor, and a large acreage of small grain, it is possible that a tractor binder would prove economical on this farm by reducing the amount of horse labor at the busiest season.

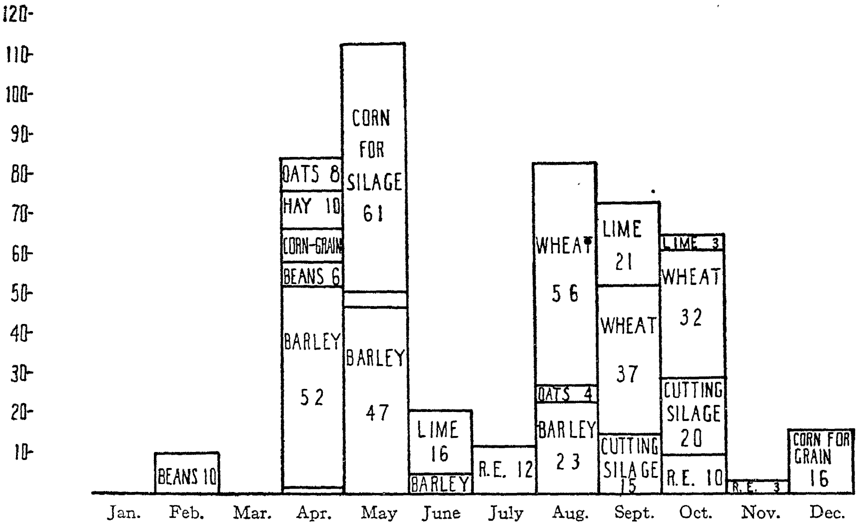


FIG. 23. DISTRIBUTION OF TRACTOR WORK IN 1918 ON THE CENTRAL NEW YORK FARM REPRESENTED IN FIGURES 21 AND 22

Total tractor work for the year, 480 hours

The distribution of horse labor on an eastern New York farm in 1919 is shown in figure 24. A tractor was purchased in the spring of 1919 and was used for a total of only 20 hours during the year, due largely to its unsatisfactory operation. The horse-labor distribution was therefore not changed by the use of a tractor. A more satisfactory tractor would have been used more, but a study of the farm and the horse-labor distribution indicates that the use of a tractor would be of doubtful economy on this farm. The month of greatest pressure of farm work was July, followed by June, May, April, August, and January. The chief operations for which horses were used in July and June were haying and cultivating. In May the principal horse operations were plowing and fitting for corn, and plowing the orchard. The number of horses kept was determined by the requirements for June and July, and it would have been doubtful economy to keep a tractor to ease the horse labor at other seasons of the year. The average hours worked per horse per working day in 1919 were 2.9. Since the number of horses could not be reduced, the greater use of the tractor for field work would have

resulted in a further decrease in the efficiency of horses. The acreage to be plowed and fitted was small, the fields were small and irregular, and there was little belt work to be done. Under these conditions it is doubtful whether the use of a tractor would have resulted in any appreciable saving of man or horse labor. This farm is typical of many in New York State.

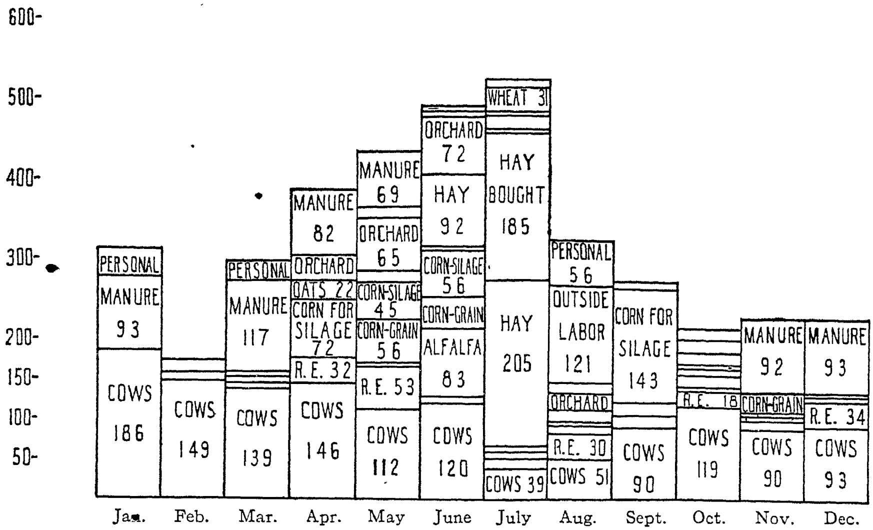


FIG. 24. DISTRIBUTION OF HORSE LABOR ON AN EASTERN NEW YORK FARM IN 1919, AFTER THE PURCHASE OF A TRACTOR

Farm area 198.3 acres; total crop area 81.1 acres: 38.5 acres hay, 8.8 acres alfalfa, 7 acres wheat, 6 acres corn for silage, 5 acres corn for grain, 4.5 acres oats, 1 acre potatoes, 16.3 acres young orchard (part of it intercropped). An average of 4.4 horses and 36 cows were kept. The average number of hours worked per horse per working day was 2.9

Of the total of 3892 hours of horse labor on this farm in 1919, 1058 were for milk hauling. The acreage to be plowed is small and the fields are small and irregular. If the roads were good, a truck would apparently be more useful than a tractor

In figure 25 is shown the approximate distribution of the drawbar work on the crops grown in 1919 on the Cayuga County farms visited. The drawbar requirements of these crops are measured in horse hours, the amount and distribution of this work for each crop being computed from the average results of complete cost accounts on New York farms for the years 1914 to 1917. Since all of these farmers used tractors in 1919, a considerable proportion of the drawbar work required was done by tractors. The high month in horse labor requirement is July, with August, May, and September following in order. The most important kinds of work in July are haying, plowing and fitting for buckwheat, harvesting wheat, and cultivating corn. An efficient tractor would be able to displace

horse labor in plowing and fitting for buckwheat, and possibly in cutting wheat. The displacement of horses in plowing for buckwheat is probably more important than it appears, because the ground is frequently dry and hard, and the weather hot, at the time when this work is done. Under such conditions, a tractor has a greater advantage. In the other months of pressure of horse work, plowing and fitting for winter wheat, oats, barley, and corn are the most important operations. In this work a tractor could replace horses to a greater extent than in July. The same

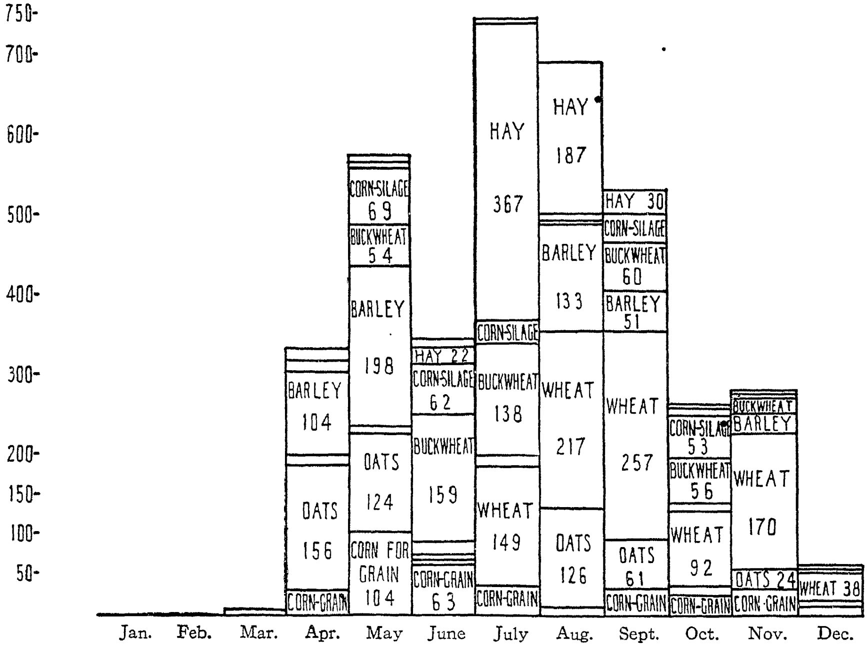


FIG. 25. APPROXIMATE DISTRIBUTION OF DRAWBAR WORK IN 1919 ON CAYUGA COUNTY FARMS VISITED

conditions of dry soil and hot weather frequently prevail when plowing and fitting for buckwheat, and for this work a tractor would be particularly useful. While the acreage in hay on these farms is large and the requirements of horse labor in July probably still determine the number of horses kept on most farms, there are about 90 acres per farm to be plowed and fitted each year, and conditions are therefore more favorable to the displacement of horses by tractors than in most other parts of New York.

RELATION OF SIZE OF TRACTOR TO SIZE OF FARM AND OTHER FACTORS

The cost, when new, of three-plow tractors is usually greater than that of two-plow machines (table 8, page 66). This results in higher interest

and depreciation costs. Repairs, fuel, lubricants, and most other costs of operation, are also greater for the larger tractors. The three-plow tractors on the farms studied averaged 543 hours of work each in 1919, as compared with an average of 395 hours for all of the two-plow tractors (table 37). This increase of almost 150 hours in the hours worked by the three-plow tractors would naturally result in a lower cost per hour

TABLE 37. Relation of Size of Tractor to Cost of Operation

	Two-plow tractors				Three-plow tractors	
	All		350 or more hours work in 1919			
	Quantity	Value	Quantity	Value	Quantity	Value
Number of farms	70	......	34	......	15	......
Hours worked per tractor in 1919	395	......	568	......	543	......
Average rated horsepower	8.7–17.1	......	8.9–17.3	......	10.8–21.3	......
Cost per hour of tractor work:						
Depreciation	....	$0.448	....	$0.347	....	$0.409
Repairs	....	0.099	....	0.072	....	0.129
Interest	....	0.095	....	0.072	....	0.091
Farm labor on tractors (hours)	0.19	0.096	0.17	0.089	0.15	0.078
Lubrication	....	0.092	....	0.086	....	0.080
Use of buildings	....	0.013	....	0.009	....	0.007
Automobile use	....	0.007	....	0.003	....	0.004
Insurance	....	0.001	....	0.001	....	0.000
Horse labor	....	0.001	....	0.000	....	0.001
Total costs other than fuel and operator	....	$0.852	....	$0.679	....	$0.799
Kerosene (gallons)	1.28	$0.197	1.31	$0.202	1.89	$0.309
Gasoline (gallons)	0.41	0.103	0.39	0.099	0.30	0.076
Total fuel (gallons)	1.69	$0.300	1.70	$0.301	2.19	$0.385
Total cost of tractor without operator	....	$1.152	....	$0.980	....	$1.184

for them, and would therefore decrease the apparent difference in cost between the two sizes of tractors. The effect of the increased number of hours worked by the three-plow tractors is shown in the lower cost of depreciation, interest, and work on tractor per hour of tractor work. As would be expected, the fuel consumption and cost were considerably larger for the three-plow tractors. In order to compare the average costs per hour for two- and three-plow tractors working an approximately equal number of hours, the average costs of two-plow machines working more than 350 hours in the year 1919 are also given in table 37. These results show an increased cost of about 20 cents an hour for three-plow tractors, with 1919 prices.

The average increase in size of farm and in crop area, by farmers who purchased two-plow tractors, was less than for those who purchased three-plow tractors (table 38). Considering their present farms, the owners of two-plow tractors estimated that their tractors displaced fewer

TABLE 38. RELATION OF SIZE OF TRACTOR TO VARIOUS FACTORS

	Two-plow tractors			Three-plow tractors		
	Year before purchase of tractor	In 1919 after purchase of tractor	Gain or saving	Year before purchase of tractor	In 1919 after purchase of tractor	Gain or saving
Total acres per farm	162.7	171.8	9.1	194.4	220.9	26.5
Total acres of land in crops per farm	117.4	123.1	5.7	144.0	165.2	21.2
Work animals per farm	6.1	4.5	1.6	6.9	4.4	2.5
Months of labor other than operator	16.4	13.4	3.0	15.8	13.1	2.7
Average annual cost of belt work per farm	$104.40	$60.70	$43.70	$137.60	$50.70	$86.90

horses and less hired labor than was estimated by the owners of three-plow tractors (table 39). The average investment per horse displaced in tractor only (not including any tractor tools) was $385 for the two-plow tractors and $468 for the three-plow tractors.

TABLE 39. RELATION OF SIZE OF TRACTOR TO NUMBER OF HORSES AND MEN DISPLACED

	Two-plow tractors			Three-plow tractors		
	In addition to tractor	Without tractor	Saving by use of tractor	In addition to tractor	Without tractor	Saving by use of tractor
Estimated number of horses needed per farm on present farms	4.2	6 6	2.4	4.7	7 5	2.8
Estimated number of months of labor other than operator needed per farm on present farms	16.2	20.3	4.1	14.4	18.9	4.5

The larger investment in tractor tools on farms using three-plow tractors was due partly to the increased cost of larger drawbar tools, but more to the fact that the larger tractors were used to a greater extent for belt work. A partial offset to the increased investment in tractor equipment was the decreased outlay for hired belt work. In general, the larger tractors designed to pull three or more plows are more satisfactory sources of belt power for machines such as large ensilage blowers and threshers. While smaller tractors may be satisfactorily used on smaller-sized ensilage blowers and threshers for home work, where much custom work is to be done a larger tractor is usually preferable. On these farms only 6 per cent of all work done by two-plow tractors was custom threshing and silo filling, while this work constituted 26 per cent of all work done by three-plow tractors (table 40).

TABLE 40. Relation of Size of Tractor to Work Done and Fuel Consumed

	Number of farms reporting each operation		Hours per farm annually		Per cent of total hours of tractor work		Gallons of fuel per 10-hour day	
	Two-plow tractor	Three-plow tractor	Two-plow tractor	Three-plow tractor	Two-plow tractor	Three-plow tractor	Two-plow tractor	Three-plow tractor
Drawbar work, home:								
Plowing	56	15	88.9	117.7	23	22	17.3	23.5
Harrowing	65	10	121.5	78.5	31	14	16.6	18.6
Disking	57	13	81.3	84.5	21	16	17.7	23.1
Other home drawbar work	23	8	16.6	15 2	4	3	12.7	16.2
Total home drawbar work	69	15	308.3	295.9	78	54	16.9	21.7
Total custom drawbar work	22	9	14.3	28.1	4	5	17.4	21.8
Total drawbar work	69	15	322.6	324.0	82	60	16.9	21.7
Belt work, home:								
Filling silo	27	8	5.1	10.1	1	2	17.6	23.4
Threshing	14	8	4.7	24.0	1	4	17.6	23.3
Other home belt work	53	10	19.6	23.7	5	4	14.2	18.6
Total home belt work	56	13	29.4	57.8	7	11	15.3	21.4
Belt work, custom:								
Filling silo	11	7	5.6	24.8	1	5	23.5	24.3
Threshing	12	6	18.0	113.1	5	21	18.7	23.5
Other custom belt work	16	5	19.4	23.6	5	4	15.5	16.4
Total custom belt work	28	11	43.0	161.5	11	30	17.9	22.6
Total belt work	56	13	72.4	219.3	18	40	16.8	22.3
Total home work	70	15	337.7	353.7	85	65	......	....
Total custom work	69	13	57.3	189.6	15	35	......	....
Total work	70	15	395.0	543.3	100	100	16.9	21.9

The results given in table 41 show that on these farms about one-third more land was plowed per day, on the average, with the three-plow tractors. In harrowing and disking, the average acreages covered per day were

TABLE 41. Relation of Size of Tractor to Efficiency

Operation	Size of tractor	Acres per farm	Per cent of total of each operation done by tractor	Acres per 10-hour day with tractor	Horse equivalent of tractor	Gallons of fuel per acre
Plowing	Two-plow	39.2	57	4.4	6.8	3.9
Plowing	Three-plow	69.7	72	5.9	9.1	3.9
Harrowing	Two-plow	271.4	83	22.3	5.6	0.7
Harrowing	Three-plow	185.5	73	23.6	5.9	0.8
Disking	Two-plow	138.4	99	17.0	9.0	1.0
Disking	Three-plow	133.7	100	15.8	8.4	1.5

approximately equal. This is due partly to the fact that most of the three-plow tractors used on these farms were heavier, slower machines, and their advantage in greater width of tools was offset by the greater speed of the lighter tractors. Considering all kinds of drawbar work, the owners of two-plow tractors estimated that, on the average, a man would accomplish about twice as much work in a day with these tractors as with ordinary horse teams, while the owners of three-plow tractors

estimated that a man would do a little more than two-and-a-half times as much work in a day with a tractor as with horses. This would indicate that on the average a three-plow tractor may be expected to do about one-third more work per day than a two-plow tractor. The fuel consumption per acre and the cost per acre of the two sizes of tractors would probably be approximately equal.

The effect of the purchase of farm tractors in increasing the average size of these farms has been mentioned previously (tables 34, 35, and 38). In this respect the tractor has been but continuing the economic changes begun when the first labor-saving machines came into use many years ago. The use of improved farm machines increases the efficiency of man labor and thus increases the amount of land that can be worked by one farmer; but a farm business must be of sufficient size to permit the economical use of the machine in order to justify the investment. Many farms must continue to use old methods because the amount of work to be done by the machine is too small to warrant the necessary investment.

It is impossible to say how large a farm must be to justify investment in a tractor. Much depends on the type of farming, the farm layout, the topography of the farm, the soil type, the drainage, the number of horses that the tractor will displace, the financial condition of the farmer, and other factors. A comparison of the average size of the farms using tractors and the average size of all farms in the respective regions as shown by the census of 1918, is given in table 42. In Cayuga County the farms using tractors were more than twice the average in total area

TABLE 42. RELATION OF SIZE OF FARMS ON WHICH TRACTORS ARE USED, TO AVERAGE SIZE OF FARMS IN THE REGIONS STUDIED

	Monroe County		Cayuga County		New York State	
	Farms visited using tractors in 1919	Average for region from census of 1918	Farms visited using tractors in 1919	Average for region from census of 1918	133 farms using tractors reporting by questionnaire	Average for State from census of 1918
Average size of farms (acres)	147.7	69.4	216.5	91.6	201.6	103.2
Average area of land in crops (acres)	111.0	56.4	153.9	56.8	110.4	48.8

and nearly three times the average in crop area. In Monroe County the farms using tractors were about twice as large as the average both in total area and in crop area. Likewise, the average area of land in crops of 133 farms in all parts of the State sending in complete answers to questionnaires, was more than twice the average area of land in crops

for all farms in the State. In Cayuga County the tractor owners estimated that on the average their tractors did only 50 per cent of the work which they could do in the available working season. In the fruit region, the corresponding figure was 62 per cent. In other words, after enlarging their farms as previously shown, and in addition to custom work, these operators believed that they could still do from 65 to 100 per cent more work with their tractors in the available working season. It would seem from this that some further increases in the size of farms on which tractors are used might be expected when the farm labor situation becomes normal.

A disadvantage in the use of tractors in New York that was frequently mentioned is that by the use of a tractor one man can put in more crops than he can harvest with present methods. The ordinary farm tractor is not so efficient in the lighter, rapid operations of haying and harvesting as in plowing and fitting (table 26, page 93). One solution to the problem would be the use of larger tractor tools in harvest operations. On small to medium-sized farms, the extra investment necessary to do this would not often be justified. With widely diversified crops, as in most of New York, with correspondingly smaller areas of any single crop, and with small fields of irregular shape and uneven elevation, it is not yet clear how far the general use of large tractor tools in haying and harvest will go. The results given in table 43 do not indicate that tractors are being used to any greater extent in mowing, binding, hauling a manure spreader

TABLE 43. RELATION OF ACRES OF CROPS PER FARM TO PROPORTION OF EACH OPERATION PERFORMED BY TRACTOR

Operation	Total acres or loads per farm of each kind of work					Per cent of total of each kind of work done by tractor				
	Less than 80 acres	80 to 119 acres	120 to 159 acres	160 to 239 acres	240 acres or more	Less than 80 acres	80 to 119 acres	120 to 159 acres	160 to 239 acres	240 acres or more
Plowing (acres)	39 9	57.6	69.1	100.7	155.9	72	71	62	71	50
Harrowing (acres)	153.3	201.1	251.1	311.1	407.2	89	86	85	70	51
Disking (acres)	48.2	79 4	110.7	121.1	367.4	96	97	98	99	99
Mowing (acres)	22 8	35 2	50.4	82.7	123.9	6	3	3	0	0
Binding (acres)	19.7	42.8	52.0	84.3	113.9	16	12	12	4	12
Manure spreading (loads)	123	179	176	249	286	4	8	0	2	0
Hay loading (acres)	11.7	21.2	33 7	69 6	113.9	5	13	20	2	2
Drilling (acres)	25.0	45.4	56.7	87.4	139.2	1	2	2	0	0

or a hay loader, or drilling, on the larger farms than on the smaller. The larger areas of hay per farm are found usually in New York in regions not well adapted to tractor operation — regions of rough topography and small, irregular fields. A good team of horses will usually pull as wide a mower as conditions permit, nearly as fast as will a tractor. On large farms in the more level part of the State, where large areas of small

grains are grown, the increased use of wide-cut tractor binders, and perhaps tractor drills, may be expected.

The advantages of the large farms in tractor operation are numerous. As the average size of farm increased, the hours of tractor work annually increased (table 48). This means more efficient use of tractor and tools, and lower costs per hour of work. More horses per farm were displaced on the larger farms (table 44). The average months of hired labor per farm displaced by the use of a tractor also increased with the size of farms.

TABLE 44. RELATION OF SIZE OF FARM TO NUMBER OF HORSES AND MEN DISPLACED BY THE USE OF A TRACTOR, 208 FARMS

	Acres of crops per farm in 1919 after purchase of a tractor				
	Less than 80	80 to 119	120 to 159	160 to 239	240 or more
Number of farms	55	68	47	29	9
Average crop acres per farm in 1919 after purchase of tractor	60.5	97.9	137.3	192.8	308.0
Average increase in crop acres per farm after purchase of tractor	4.1	5.2	14.2	29.8	23.9
Estimated average number of horses needed on present farm without tractor	4.5	5.7	6.6	8.3	11.1
Estimated average number of horses per farm needed on present farm in addition to tractor	2.6	3.4	4.0	5.9	7.6
Estimated average number of horses per farm displaced by use of tractor	1.9	2.3	2.6	2.4	3.5
Average acres of crops per horse on present farm without tractor	13.4	17.2	20.8	23.2	27.7
Average acres of crops per horse on present farm with tractor	23 3	28.8	34.3	32.7	40.5
Estimated average number of months of hired labor per farm displaced by use of tractor on present farm	3.2	3.8	5.9	3.9	7.5

In all cases the use of a tractor increased the acreage of crops that one horse took care of, but the average increase was as great on the largest farms as on the smallest. An even more striking illustration of the increased number of horses displaced on the larger farms is shown in table 45.

Second in importance only to the question of whether or not to buy a tractor, is the question of the best size to buy. When farm tractors first began to be used in the United States, there was a wide variation in sizes of tractors on the market. During recent years, however, there has been a marked tendency to reduce this wide range of sizes by concentrating

on those which experience has proved the best. The best size of tractor depends on the size of farm, the kind of crops grown, and many other factors, and it would therefore be expected that different sizes of tractors would prove best under different conditions. Tractor investigations in the Middle West have shown that experience is demonstrating the superiority of three and four-plow tractors under conditions existing in those regions.

TABLE 45. RELATION OF NUMBER OF HORSES KEPT TO NUMBER OF HORSES DISPLACED

Number of horses kept before purchase of tractor	Number of farms reporting	Crop acres per horse		Estimated number of horses displaced on present farm by tractor	Estimated number of months of hired labor saved on present farm by tractor
		Year before purchase of tractor	In 1919 after purchase of tractor		
3 or less	25	19.8	27.4	2.0	2.3
4	54	21.0	28.5	2.0	3.7
5	38	21.1	31.5	2.1	4.9
6	37	17.8	27.9	2.3	4.1
7	13	21.0	27.9	2.4	4.1
8	16	22.5	31.0	3.0	5.0
9	8	18.9	29.3	3.4	6.5
10 or more	9	17.0	28.2	4.6	10.8
Total	200	....	....	....	....
Average	....	19.8	29.4	2.4	4.4

In a region studied in the Dakotas,[3] only 5 per cent of the farmers reporting recommended two-plow tractors, 52 per cent recommended three-plow tractors, and 43 per cent preferred four- or five-plow tractors. In Illinois[4] 11 per cent of the tractor owners reporting recommended two-plow tractors, 76 per cent recommended three-plow, and 13 per cent favored four-plow machines.

In the New York regions from which information was obtained, a much larger proportion of two-plow tractors was found, about four-fifths of the farmers reporting two-plow machines (table 46). The proportion of two-plow tractors purchased each year increased from 55 per cent of the tractors purchased in the years 1913 to 1916, to 89 per cent of the tractors purchased in 1919. During this same period the proportion of one-, three-, and four-plow machines decreased.

Similar proportions are shown in the size of tractors which these farmers recommend for New York conditions, based on their own experience

[3] The farm tractor in the Dakotas. By Arnold P. Yerkes and L. M. Church. U. S. Agr. Dept. Farmers' bul. 1035. 1919.

[4] Tractor experience in Illinois. By Arnold P. Yerkes and L. M. Church. U. S. Agr. Dept. Farmers' bul. 963. 1918.

TABLE 46. RELATION OF YEAR TRACTOR WAS NEW, TO PROPORTION OF DIFFERENT SIZES OF TRACTORS PURCHASED, 380 FARMS

	Number of tractors of each size purchased in				Per cent of all tractors purchased in given years			
	1919	1918	1917	1916 to 1913	1919	1918	1917	1916 to 1913
Four-plow	0	0	0	2	0	0	0	3
Three-plow	10	19	12	25	10	14	15	39
Two-plow	93	111	65	35	89	83	82	55
One-plow	1	3	2	2	1	2	3	3
Total	104	133	79	64	100	100	100	100

(table 47). More than three-quarters of the farmers reporting this information recommend the two-plow size, the remainder favoring the three-plow machine. This indicates that, in general, the two-plow tractor has proved the most satisfactory under New York conditions. These

TABLE 47. SIZES OF TRACTORS RECOMMENDED BY 254 TRACTOR OWNERS

Number of plows pulled by tractor now owned	Number of farms reporting	Average acreage of crops per farm in 1919	Per cent of owners who would buy another tractor	Per cent of present owners recommending tractors of size indicated		
				Two-plow	Three-plow	Four-plow
1	4	81.5	100	100	0	0
2	219	111 9	94	84	15	1
3	28	150.9	82	24	72	4
4	3	132.7	100	67	0	33
Total	254	....	....	......	......	....
Average	....	115.9	93	77	22	1

results may have been influenced to some extent by the fact that some of the most popular makes of tractors are made only in the two-plow size, and hence choice of sizes was impossible. The variation in preference of tractor owners' from the three- or the four-plow size in the Dakotas to the three-plow size in Illinois and the two-plow size in New York, is in conformity with variation in agricultural conditions. In New York the farms are smaller, more hay is grown, the crops are more diversified, less plowing is done, and the smaller fields, often irregular in outline and uneven in contour, decrease the efficiency of all tractors and particularly of the heavier ones. These and other factors result in a preference

for smaller, lighter tractors. The two-plow tractor is not to be universally recommended for New York conditions. The choice will depend on the size of the farm, the soil conditions, the work to be done, the type of farming, and other factors.

The results shown in table 48 offer no indication that tractor owners on the smaller farms are dissatisfied with their purchase. There are

TABLE 48. RELATION OF SIZE OF FARM TO SIZE OF TRACTOR

	Acres of crops per farm in 1919 after purchase of a tractor				
	Less than 80	80 to 119	120 to 159	160 to 239	240 or more
Number of farms	55	68	47	29	9
Average crop acres per farm	60.5	97.9	137.3	192.8	308.0
Per cent of tractor owners having one-plow tractors	4	1	2	0	0
Per cent of tractor owners having two-plow tractors	91	90	83	52	78
Per cent of tractor owners having three-plow tractors	5	9	15	48	22
Per cent of tractor owners who would buy another tractor	95	94	94	90	89
Per cent of tractor owners who would buy two-plow tractors	84	81	77	54	33
Per cent of tractor owners who would buy three-plow tractors	16	19	23	46	67
Average investment per farm in tractor equipment	$311	$362	$458	$599	$621
Average hours of home tractor work per farm	193	269	330	381	545
Average hours of custom tractor work per farm	66	103	56	120	67
Average hours of all tractor work per farm	259	372	386	501	612

many reasons besides strictly business reasons for the purchase of a tractor. The farms in the smallest group in this table average about 60 acres of land in crops per farm, or about one-fourth larger than the average New York farm.

A larger proportion of three-plow tractors is found on the larger farms. A better indication of the best size of tractor for farms of different sizes is shown by the sizes which these owners would buy, on the basis of their personal experience (table 48). On the smallest farms a large proportion of the owners would buy two-plow tractors, but this proportion decreases as the size of farms increases. With farms of 160 to 239 acres of crops, the owners are nearly evenly divided between two- and three-plow tractors, but with farms of 240 or more crop acres the majority favored the three-

plow size. Many farmers on the heavier soils expressed a desire for more power. Some recommended a three-plow tractor to be used with two-plows in order to give a reserve of power for any conditions without speeding up the tractor. Where a tractor is purchased largely to furnish power for custom belt work, the three-plow size was usually recommended.

The average investment in tractor equipment per farm increased with the size of the farm. Apparently this is not due to an increase in the amount of custom work done per farm. On the smaller farms, usually only the essential tractor tillage tools are owned, because the business is too small to justify a greater investment.

RELATION OF USE OF TRACTOR TO CROP YIELDS

In response to a question as to the effect of the use of a tractor on crop yields, 153 farmers reported no appreciable effect, 155 thought their crop yields had been increased, and 3 thought the use of a tractor had resulted in decreased crop yields. The crop mentioned most frequently as favorably affected by the use of a tractor was wheat, the average increase in yield reported by 34 farmers being 15 per cent. At the time of plowing for wheat the land is frequently dry and hard and the weather is hot. The yield of wheat is likely to be better when the ground is plowed a considerable time before planting. Under such conditions it is very difficult to do the work quickly and satisfactorily with horses. As long as a tractor can get good traction, dry, hard soil offers no serious difficulties in plowing, and the weight of the tractor and the heavy tractor disks are a great advantage in pulverizing the hard lumps and in getting a fine, firm seed bed for the wheat crop. Many farmers in the general farming region of Cayuga County stated that their primary reason for purchasing a tractor was to do the hard plowing in hot weather for wheat and buckwheat. A considerable number of farmers thought their yields of corn and oats had been increased by the use of a tractor. On the other hand, a few men reported decreased yields of spring-sown crops, principally oats and corn, because the tractor packed the damp soil. In some regions, on poorly drained soils, this is a serious difficulty.

In their opinions as to whether or not the use of a tractor resulted in cheaper work, these tractor owners were nearly equally divided, 48 believing that the tractor reduced the cost of farming, while 39 had not found any decrease.

ADVANTAGES OF TRACTOR OPERATION

The advantages as reported were numerous. In the order of frequency of mention, they were given as: ability to do heavy work fast and so speed up farm work; saving of man labor; ability to work in hot weather;

available belt power; work done on time; displacing of horses, thus saving horse feed; more thorough orchard cultivation; better work; preference for driving tractor rather than horses; farm work made easier; reserve power for emergencies; saving of horses; cheaper operation; worker could drive tractor but could not follow team; tractor does not eat when not working; no chores when tractor is not working; ability to plow deeper. The importance of some of these advantages varies in different regions. The usefulness of the tractor as a source of belt power was considered very important in the general farming region, where there was a considerable amount of belt work to be done, but was not important in the fruit region. On the other hand, the advantage of the low-down tractor in orchard cultivation — its ability to keep on harrowing in weather when horses could not work in an orchard — is of importance only in the fruit region. A number of mechanically inclined farmers reported that the chief advantage of the tractor was that they preferred to run a machine rather than drive horses. Two farmers, because of age or physical infirmity, were unable to follow a team in field work but were able to drive a tractor because they could ride in all operations.

DISADVANTAGES AND DIFFICULTIES OF TRACTOR OPERATION

Among the classes of difficulties listed in table 49, poor drainage of soil was reported as giving difficulty to the largest number of persons. Many tractor troubles result from this cause. With some operators the chief trouble resulting was that the tractor would get mired in small, wet holes which would never be noticed in working the land with horses. Twenty-seven farmers reported that the packing of moist soil was the most serious disadvantage of tractor operation, while 170 reported some difficulty because of this factor (table 49). In some cases this packing of moist soil resulted in decreased yields, particularly of spring-sown crops. Difficulty because of slipping on wet soil and difficulty in operating in sandy soil were mentioned by some operators as disadvantages. Because

TABLE 49. Number of Tractor Owners Reporting as to Difficulty in Tractor Operation for the Reasons Given

	Number reporting difficulty	Number reporting no difficulty
Stone in soil	99	283
Poor drainage of soil	170	211
Rough topography	77	307
Mechanical difficulties	106	280
Difficulty in getting efficient operator	37	328

of difficulty on damp soil some tractor owners used their tractors but little for spring plowing, doing most of this work with horses.

The next class of difficulties, in point of frequency, was mechanical difficulties. A variety of these were reported, some of which were serious while others were unimportant. Trouble with drive chains was the mechanical difficulty most frequently mentioned. These difficulties ranged from the ordinary, but exasperating, breaking of links in worn drive chains, to the breaking of sprockets by stones or trash picked up by the wheels and dropped on the chain. Other mechanical difficulties in the order of frequency of mention were: cutting out of gears exposed to dust; magneto trouble; force-feed oiling system; lack of power; weak construction of drive wheels; breakage of track and track wheels; poor traction; hard starting; and the large amount of water used.

Stone in soil and rough topography also gave difficulty to many tractor operators, and of these two the latter in general is the more serious. Fast stones give serious trouble to many tractor operators, particularly in plowing, but only in scattered areas. However, a large part of the crop land in New York is more or less rolling, and this difficulty is therefore more important to New York farmers. Both the regions visited by the writer were so nearly level that little difficulty was found because of this factor. Answers to questionnaires received from the regions of rougher topography show that many tractors that gave excellent satisfaction in level regions are failures on any real slope. Farmers in the hilly regions who are considering the purchase of tractors should insist on a demonstration on their own farms before closing the bargain.

Difficulty in getting efficient operators was reported by a number of owners. Many more reported that they would have trouble in hiring satisfactory operators, but that they ran their tractors themselves. As previously mentioned, this difficulty is due largely to the newness of the tractor and will tend to disappear as hired men become as skilled in tractor operation as in operating other kinds of farm machinery.

Of 87 tractor owners in the regions visited, 6 reported that the operator had been injured in running the tractor. These injuries ranged from a smashed finger to broken arms and ankles. The time lost due to such injuries ranged from a few days to six weeks. In spite of these injuries the majority of the owners did not consider a tractor more dangerous than horses.

Small, irregular fields offer a serious handicap to the efficient use of tractors on many farms. It is possible to operate one of the small modern tractors in such fields, but it is difficult to do efficient work under such conditions because of the time lost in turning and in getting into corners. Nineteen of the farmers visited had either already made or were planning

to make changes in their farm layouts which would increase the size or improve the shape of the farm fields, or both. This factor is worthy of attention in many cases.

Other disadvantages of tractor operation frequently mentioned were: tractor too high to work satisfactorily in orchard; tractor too heavy; tractor too slow; tractor too expensive; poor service on parts and repairs; tractor hard to steer; impossible to turn tractor short; tractor interfered with management of farm; tractor was dirty; tractor was noisy; large investment necessary. Some of these disadvantages applied only to certain makes and models of tractors, while others were general, applying to all makes.

A number of farmers criticized the attitude of the tractor manufacturers toward purchasers. In the past, many of them pursued a short-sighted policy, paying much more attention to selling their machines than to helping buyers get satisfactory service from their investment. According to reports received, the experiences of some farmers have convinced them that some tractor manufacturers and their salesmen are as bad as the old-time horse jockeys to deal with. One farmer purchased a supposed 1918 model of a well-known make, only to find, after using it, that it was a 1917 model. It did not do satisfactory work, and to save litigation the company rebuilt the machine. Even then it failed to perform satisfactorily and the farmer traded it in toward a tractor of another make, losing $1000 in the transaction. This was indeed expensive experience. In return for his money he got about two months of unsatisfactory work. In his second venture this farmer again got unsatisfactory results. The lugs on the drive wheels were not long enough to cover the extension rims, and hence did not give good traction on his sandy soil. The magneto also was defective. This was not an isolated case, as 8 machines out of 30 of the same make in his vicinity had magneto trouble. In order to get the defective parts replaced, this farmer was forced to pay for new parts. Counting the loss on the first machine, this farmer considers his investment in his present two-plow tractor as $2375. Another farmer, moved by patriotic appeals during the war, rented another farm adjoining his own and bought a tractor on contract to be delivered on April 1, 1917, paying $350 down. It did not come as agreed, and after waiting for some weeks he made a special trip to the factory. At the factory he got promises of immediate shipment, but after waiting until May 17 he finally bought a tractor of another make in order to avoid losing the use of his farm for the year. In the fall the company notified him that the tractor contracted for was ready for delivery. He refused it and lost the $350 he had paid down. The lawyer to whom this farmer took his troubles told him that the contract was crooked and that he could not get a cent

of his $350 back. Such sharp practices certainly do not encourage confidence on the part of farmers, in either the tractor companies or their product. Probably tractor manufacturers are as honest and honorable as any other class of persons. Most of the companies have replaced defective parts without charge. This is certainly the least that they could honorably do. The time lost due to such breakdowns could not be replaced.

In a new and rapidly developing industry it was doubtless unavoidable that many new and untried machines would be placed on the market. Most of the experimental work on some machines had apparently been done by and at the expense of the farmer purchasers. Such tractors have seriously hindered the development of the tractor industry.

There has been a commendable change in the attitude of manufacturers toward their customers. Most of them now realize that their responsibility does not cease when they have unloaded their product for cash on an unsuspecting farmer. Through their agencies and dealers they must stand behind their machines and make good. And even after the tractor has made good, the manufacturers must continue to give good service on the necessary repairs that must be made from time to time on even the most dependable of tractors. After all, the best asset and the best salesman for any manufacturer of any product is a satisfied customer.

TRACTOR PLOWS

In addition to the information on costs and effects of tractor operation, data were obtained on 43 of the farms visited regarding the costs of tractor plows (table 50). As in the case of tractors, the most important item of cost is depreciation, constituting one-half or more of the total annual cost. Next in importance is the cost of points. The majority of owners of plows used steel points. These do not break easily and can be resharpened from time to time, but, because of their high cost, many owners depend on cast points. The average cost per acre of the two-bottom plows was 81 cents, comparing closely with 79 cents for three-bottom plows. At the average rates of plowing (table 41, page 119), the average cost per tractor hour for the tractor plow would be 36 cents for two-bottom plows and 47 cents for three-bottom plows.

The tractor plow is like the tractor in that it is a comparatively recent development and not yet fully perfected. A great deal of the criticism of tractor plowing has been due quite as much to the plow as to the tractor. Tractor plows were first widely used in the Middle West, and many types that had been successful under the conditions there were sold for use in New York. It could not reasonably be expected that such plows would give satisfaction under the different soil conditions on New York

farms. About two-fifths of the farmers visited in Cayuga, Monroe, and Orleans Counties thought they did as good plowing on sod with a tractor as with horses. A few thought they could do better plowing on sod with the tractor. The remainder could not do as good plowing on sod with the tractor as with horses. In plowing on stubble the proportion was somewhat greater, more than four-fifths reporting that they could do as good plowing on stubble with the tractor as with horses. Among those who could not plow satisfactorily with their tractors, the trouble was ascribed to difficulty with the plows as much as with the tractors. The makes of tractor plows which were designed for western conditions gave particular trouble. In a few cases this was due to fast stone rather than to trouble with either plow or tractor. About one-fourth of these farmers reported that it took more time to fit tractor-plowed land than land plowed with horses, the average amount of extra time required for these farms being estimated at about 8 per cent.

TABLE 50. COSTS OF OPERATION OF TRACTOR PLOWS

	Three-bottom plows		Two-bottom plows	
	Quantity	Value	Quantity	Value
Number	10	....	33	....
Average cost when new	....	$219.40	....	$142.30
Average value in 1919	....	155.20	....	114.79
Average seasons used	2.0	....	2.0	....
Estimated total years of useful life	8.5	....	9.9	....
Acres plowed at home	80.1	....	55.7	....
Acres plowed for others	13.7	....	5.3	....
Total acres plowed	93.8	....	61.0	....
Average width of plows (inches)	13.4	....	13.6	....
Annual costs per tractor plow:				
Interest	....	9.31	....	6.88
Depreciation	....	43.50	....	23.64
Use of buildings	....	2.16	....	2.48
Grease (pounds)	4.2	0.69	2.9	0.48
Points	9.5	16.04	6.7	12.39
Repairs	....	0.60	....	1.58
Man labor (hours)	7.5	2.16	6.5	1.99
Total cost for year	....	74.46	....	49.44
Cost of plow per acre	....	0.794	....	0.811

SUMMARY

In recent years many New York farmers have purchased tractors, and in the years to come many more will do so. Many men have bought tractors because it is the popular thing to do, but for most farmers the question of purchasing a tractor is a business proposition. To be

economically justifiable a tractor must decrease farm costs or increase farm returns enough to pay. An attempt has been made to bring together in this bulletin information from the experience of tractor owners that would prove useful to prospective purchasers in reaching a reasonable decision on the tractor question.

The average cost of operation of a tractor without an operator for the year 1919 on these farms was $1.16 an hour and the average cost of a tractor operator was 50 cents an hour, making the average cost of tractor and operator $1.66 an hour. The average rate of tractor plowing on these farms was 4.8 acres in 10 hours, making the average cost of tractor and operator in plowing, $3.46 an acre. Including the cost of a tractor plow, 80 cents an acre, the total average cost of tractor plowing was $4.26 an acre.

The average annual cost of tractor operation on these farms in 1919 was $660 for tractor and operator. The largest single item of cost was depreciation, which amounted to $187.25 per tractor. Other costs in order of importance were tractor operator, fuel, repairs, interest, work on tractor by farm labor, lubricants, automobile use, horse labor, insurance, and use of buildings. The average estimated life of these tractors was six years.

The average number of hours worked by these tractors annually was 425 hours, of which 321 hours were drawbar work and 104 hours were belt work.

The relative efficiency of tractor and horses varies in different kinds of work. At heavy work, such as plowing and disking, a tractor accomplished as much on the average in a day as from seven to nine horses. At harrowing, a tractor accomplished as much as six horses; at binding corn or grain, as much as from four to five horses; and at mowing, as much as three horses. This helps to explain the general opinion of these farmers that the use of tractors is profitable on heavy operations but that horses are cheaper for the light, rapid operations.

On 46 farms in a general farming region, an average of 1.6 less horses per farm were kept after purchasing a tractor and at the same time the average size of the farms was increased by nearly 17 acres per farm. Less hay and grain were fed to horses after tractors were purchased, partly because of the fewer horses kept and partly because less grain was fed per horse after the purchase of a tractor.

These farmers estimated that on their present farms they need 2.4 fewer horses per farm and four months less of hired labor per farm than would be needed if a tractor were not used.

Data are presented showing the various kinds of work for which tractors were used, the kinds and costs of and the average investment in tractor

equipment, the relation of size of farm to tractor use and size of tractor, and the effect of tractor use on other points of farm organization.

By way of emphasizing the more important factors to be considered, some of the conditions favorable to tractor operation are given as follows:

1. Level topography. Steep slopes are one of the most serious obstacles to successful tractor operation.

2. Soil well drained and reasonably free from stones. Wet spots in farmed fields constitute one of the most serious difficulties of tractor operation. Even if miring is avoided, the packing of moist soil will often have an injurious effect on crop yields. While surface stones do not often give serious trouble, fast stones are a serious disadvantage in tractor plowing.

3. Good farm layout. Large fields of oblong shape offer the best opportunity for efficient tractor operation. Too frequent turning can be avoided by long fields, 100 rods long or longer if the fields are large enough to permit this length.

4. A farm large enough to keep the tractor busy at profitable work throughout the working season. The most effective way of reducing tractor costs is to keep the tractor busy at profitable work.

5. Plenty of belt work in addition to field work. This helps to keep the tractor busy at profitable work, and thus reduces the cost per hour of operation.

6. Horse labor distribution such that the greatest pressure of work is plowing and fitting, or other heavy work that can be done economically by a tractor. If the number of horses kept is determined by the requirements of plowing and fitting, together with other work which must be done at that time — other conditions being favorable — a tractor that could do a large part of this work efficiently would be able to displace some horses. On the other hand, if the season of greatest pressure of horse work is that of haying, cultivating, and harvest, a tractor will be able to displace fewer, if any, horses.

7. Available capital for tractor and tractor equipment. Tractor tools are almost as necessary as the tractor itself, to get efficient use of the machine. The necessary investment will depend on the size of farm and the type of farming, but in any event it will amount to considerably more than the bare cost of the tractor.

8. Mechanical ability and experience. These are essential to successful tractor operation. Almost any intelligent person familiar with gas engines and other farm machinery can soon master the fundamentals of tractor operation. Tractor or gas-engine schools are available in almost every community to assist the beginner.

9. Labor scarcity. The saving of man labor by tractors is usually of greater importance than the saving of horses. In times of labor shortage, the ability to increase the effectiveness of man labor is one of the most important advantages of the tractor.

10. High-priced horse labor. The ability of a tractor to displace horses is more important when the cost of horse labor is high. The relative prices of horse feed and tractor fuel constitute one important factor to be considered in deciding on the tractor question.

The question of whether or not to buy a tractor is an individual problem that each farmer must decide for himself. The first part of the problem is, would it pay? If from a study of the farm, considering the experience of others, it appears that this question is answered in the affirmative, the next question is, would this investment pay better than any other that can be made at this time? Most farmers have a limited amount of available capital and a choice of many profitable ways for investing it. Among these various ways of investing, which will pay the best returns on the money available? The alternative forms of investment may be the farm mortgage, tile drainage, purebred stock, better buildings, lime, a tractor, electric lights, a water system, and so on. It is not enough to know which forms of investment would pay. Perhaps all would prove profitable. The order in which they should be made, however, should be decided on the basis of their relative profitableness. Which would pay best?

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Decomposition of Green Manures at Different Stages of Growth

Thomas Lysons Martin

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CONTENTS

DECOMPOSITION OF GREEN MANURES AT DIFFERENT STAGES OF GROWTH

Thomas Lysons Martin

The value of organic matter in soil improvement has long been recognized. It benefits the tilth of the soil, affects the availability of the nutrients, stimulates bacterial activity, and gives to the soil a greater crop-producing power. Farm manures and green manures are the principal sources of this organic material. Green manures, as one of the sources of organic matter, are increasing in importance as the need for soil humus is becoming more widely recognized.

The humus stage of decomposition is in all likelihood the period at which many of the desirable effects of manures are produced. The ease with which a manure reaches this stage is probably a measure of its effectiveness. It is well known that plants vary, according to their degree of maturity, in the readiness with which they are broken down into humus. However, the exact stage of growth at which the crops used as green manures decompose most rapidly and exert their greatest influence on the soils so treated is yet to be determined.

The investigation here described was undertaken with the purpose of throwing some light on this question.

REVIEW OF LITERATURE

A survey of the literature of the subject indicates that the work thus far has been only of a general nature. The effect of the manures on the soil has been studied, and incidentally, in these studies, it has been found that the young material, as compared with the old, decomposes more rapidly. Not much attention has been given to attempting to find the period when the plant used as a green manure decomposes most rapidly and has the greatest influence on the various soil activities.

Muntz (1890)[1], in his investigations, found that the value of green manuring is proportional to the rapidity with which the nitrogen is converted into nitrates.

Snyder (1895) placed a mixture of soil and green clover in boxes and allowed it to ferment for one year. In a majority of cases he found an increase in the availability of the phosphorus and the potassium of the soils so treated.

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[1]Dates in parenthesis refer to *Literature Cited*, page 157.

Author's acknowledgment. The writer acknowledges the help received from Dr. J. A. Bizzell, under whose direction this work was done.

Conn (1901) says:

The building of nitrates will not take place in the soil so long as there is any considerable amount of organic material or any considerable amount of free ammonia present. If there is much organic material rapidly decomposing so as to produce ammonia, this will completely check the formation of nitrates, for these nitrifying bacteria will not grow in the presence of either organic material or ammonia. It is not until after decomposition has been completed and practically all the organic compounds used up that the nitrifying germs can begin to act.

Marshall (1912) states that under suitable conditions the accumulation of humus in the soil stimulates nitrification to a very striking extent.

Velbel (1914) found that soil nitrification increases directly with the rate of decay of the humus-forming material.

Hutchinson and Milligan (1914) used nitrate accumulation in the soil as a measure of organic decay and found that the percentage of nitrification decreased markedly with the age of the green material added.

Hill (1915) found that the nitrogen of green manures appears to pass rapidly into the nitrate form as the decay processes advance.

Using chemical analyses and subsequent crop growth as a measure, Hopkins and Aumer (1915) found that decomposing green manures increase the availability of the nutrients in the soil. Potassium seemed particularly influenced.

Wright (1915) plowed under green manure, which decayed rapidly, the decay being accompanied by vigorous nitrification. When resistant material was added, it reduced the rate of nitrification.

Brown and Allison (1916) claim that the application of large quantities of humus-forming material to soils increases ammonification and nitrification to a very considerable extent. They found that straw, due to its greater resistance, does not increase nitrification as much as do green manures.

White (1916), utilizing crimson clover as a green manure, found that the younger the crop when plowed under, the more rapidly did it decay. A corresponding stimulation was also observed in the growth of a subsequent tomato crop.

Maynard (1917) studied the rate of decomposition of a sweet-clover green manure, and, using the accumulation of nitrates in the soil as a measure, found that the rate of decay decreases as the maturity of the plant tissue is approached.

Carr (1917) suggested that, since humus formation is a step in the process of decomposition, the rate of decay may be measured by the rate at which humus is produced.

Merkle (1918) used the rate of humus formation and the evolution of carbon dioxide as a measure of the degree of decay, and found that the greater the succulency of the material studied and the greater its nitrogen content, the more rapidly does it decay.

These citations suffice to show that green manures are of value; that the younger the material when incorporated with the soil, the more rapidly does it decompose; and that as it decomposes, its favorable influence on the soil is proportional to the rate of decay. This information is all of a general character. There is nothing to indicate the exact stage in the growth of the plant at which these favorable influences occur. The knowledge that has been obtained has been based on a single method of measurement of the rate of decay. Unfortunately, no one method has been devised which in every respect satisfactorily indicates the rate of organic decomposition in soils. It therefore becomes necessary, in investigations of this nature, to use a variety of methods, each one of which will tend to check up the others. The results from such a procedure should consequently be more conclusive than results otherwise obtained.

It is the aim of the present investigation to follow such a plan, and to determine, if possible, at what stage of growth the crops used as green manures decompose most rapidly and what effect this stage has on the soil so treated.

EXPERIMENTAL WORK

PLAN OF THE INVESTIGATION

The method of conducting the investigation here discussed is briefly outlined as follows:

Dunkirk clayey silt loam, a glacial-lake soil comprising the larger part of the soil on the Cornell University experimental farm, was used in the work. This soil was passed thru a 2-millimeter sieve, and samples of 3600 grams each were then weighed into one-gallon jars, the inside dimensions of which were $7\frac{1}{2}$ by 7 inches.

Rye, oats, and buckwheat were used as green manure, each crop being obtained at three different stages of growth. The material, while still fresh, was cut into pieces of about one inch in length, and thoroly mixed with the soil. The mixture was then brought to and maintained at a moisture content of 25 per cent, and was kept at a constant temperature in the greenhouse. Untreated soils served as checks. All incorporations were made in triplicate.

The investigation consisted of a series of three experiments and covered a period of three years. The experimental series were as follows:

Series 1916. Equal green weights of rye, oats, and buckwheat, respectively, at three stages of maturity, were incorporated with separate samples of soil and incubated for twelve months.

Series 1917. Equal dry weights of the same crops were added to separate soil samples and incubated for four months.

Series 1918. Nine areas of soil were sown to rye, oats, and buckwheat, respectively, three areas being given to each crop. Green material, representing the first, second, and third stages of maturity for each crop, was then successively obtained from the respective areas, for incorporation with the soil to be experimented on. With increase in maturity, there was, of course, a corresponding increase in the green and the dry weights added to the soil, thus approximating field conditions.

The areas selected for the rye crop were each 4.4 square feet, the total material produced at each stage being divided equally among the three triplicate pots. The areas for oats and buckwheat were 4.5 and 3.4 square feet, respectively. These crops were treated exactly as was the rye.

In representing the successive stages of maturity in the tables and diagrams on the following pages, the letters *A*, *B*, and *C* are used. For the three series, and for the three different crops used, the stages of growth indicated by these letters are as follows:

SERIES 1916

Crop		Height	Condition
Rye	A	16 inches	Boot stage
	B	38 inches	Well headed
	C	60 inches	Almost ripe
Oats	A	10 inches	Preceding boot stage
	B	24 inches	Boot stage
	C	36 inches	Almost ripe
Buckwheat	A	12 inches	Blossoming
	B	30 inches	Well blossomed
	C	36 inches	Seeds forming

SERIES 1917

Crop		Height	Condition
Rye	A	60 inches	Fully headed
	B	65 inches	Heads yellow
	C	72 inches	Ripe
Oats	A	48 inches	Fully headed
	B	60 inches	Heads yellow
	C	62 inches	Ripe
Buckwheat	A	40 inches	Well blossomed
	B	48 inches	Seeds forming
	C	48 inches	Ripe

Series 1918

Crop		Height	Condition
Rye	A	24 inches...	Preceding boot stage
	B	48 inches...	Blossoming
	C	48 inches...	Almost ripe
Oats	A	11 inches...	Boot stage
	B	30 inches...	Well headed
	C	36 inches...	Almost ripe
Buckwheat	A	10 inches...	Blossoming
	B	20 inches...	Well blossomed
	C	26 inches...	Almost ripe

After various periods of incubation, soil samples were taken from each of the pots and analyses were made to determine the rate of decay.

With investigations of this nature, the methods used for determining the amount of decomposition are of prime importance. As previously stated, no single method has been devised which in every respect satisfactorily indicates the rate of organic decay in soils. The methods already suggested, and tested to some extent, are as follows: (1) determination of the rate of humus formation; (2) determination of the rate of evolution of carbon dioxide; (3) study of the accumulation of nitrates; and (4) study of the increased availability of plant nutrients as measured by the effect on subsequent plant growth.

Each of these methods is open to objection. In making humus determinations, the humus extract is difficult to filter and the process is in consequence associated with such a large experimental error that the results are not dependable. Gortner (1917) used this method and found no evidence that an increase in soil humus was brought about by specific humification. He found maximum ammonia-soluble material present in the soil immediately after green manures were turned under and before humifying bacteria could have begun work. Carr (1917) obtained similar results while attempting to discover whether the humus content of the soil was a measure of its fertility. Christie (1916), studying the decomposition of organic matter in the soil, stated that the percentage of humus was not necessarily an index of the value of the organic matter in the soil.

The rate of evolution of carbon dioxide as an indicator of the rate of decay is dependent on a number of soil conditions. The looseness which the organic material produces in the soil influences the ease with which the carbon dioxide is extracted. The amount of carbon dioxide utilized by the bacteria as a source of carbon is also a factor. Moreover, certain groups of organisms in the soil produce only intermediate products, such

as butyric and acetic acids, and this condition must also be considered in using this method.

When the accumulation of nitrates is used as a measure of organic decay, the possibility of a large probable error should not be overlooked; for much of the nitrogen that might otherwise be changed to nitrates is used by the organisms present in the soil, while the method used for obtaining a soil extract for nitrate determination may introduce a further source of error.

The increased crop growth on soils receiving treatments of decaying organic materials may be due to factors other than the increased availability of plant nutrients. The tilth is improved by the placing of the soil in the pots; and this, in turn, has a stimulating effect on the biological and chemical reactions in the soil.

The foregoing criticisms of the means available for measuring the rate of organic decay indicate that the use of one method alone may not give very dependable results. As previously stated, it is obviously better, in an investigation of this kind, to use several methods, each one tending to check up the others. The results obtained from such a procedure should be more conclusive by far.

In the present investigation, the following methods were used to measure the rate of decay:

(1) Determination of the rate of humus formation;

(2) Study of the accumulation of nitrates;

(3) Study of the increased availability of plant nutrients as measured by the effect on subsequent plant growth.

The method of measuring the rate of decay by a determination of the rate of evolution of carbon dioxide was omitted because it was thought that three methods, each one of which would tend to check up the others, would give amply significant results.

The amount of humus in the soil sample obtained from each pot was determined according to the method recommended by the United States Bureau of Chemistry (1912), with the exception that 50 grams of soil was used instead of 5 grams. The humus extract was filtered thru a 10-centimeter Buchner funnel, the treated soil serving as a filter.

Nitrates were determined according to the method given by Schreiner and Failyer (1906).

Total nitrogen was determined according to the Kjeldahl-Gunning method (U. S. Bureau of Chemistry, 1912).

After the soils had been sampled for analysis, wheat was planted in each pot and grown to maturity. The moisture content, while the crop was growing, was kept at 25 per cent, the optimum condition for this particular soil.

RESULTS

Effect of stage of growth of green manure on rate of humus formation

It would appear in general, from the curves shown in figures 28 and 29 that the greater the succulency of the manure when incorporated with the soil, the larger is the amount of humus formed.

The first marked exception to this generalization, however, appears in figure 27, showing the results of allowing the material to decompose for twelve months. Here, in every instance, the most succulent crop resulted in the least amount of humus. This is in exact opposition to the results shown in figures 28 and 29, when the manure was allowed to decompose

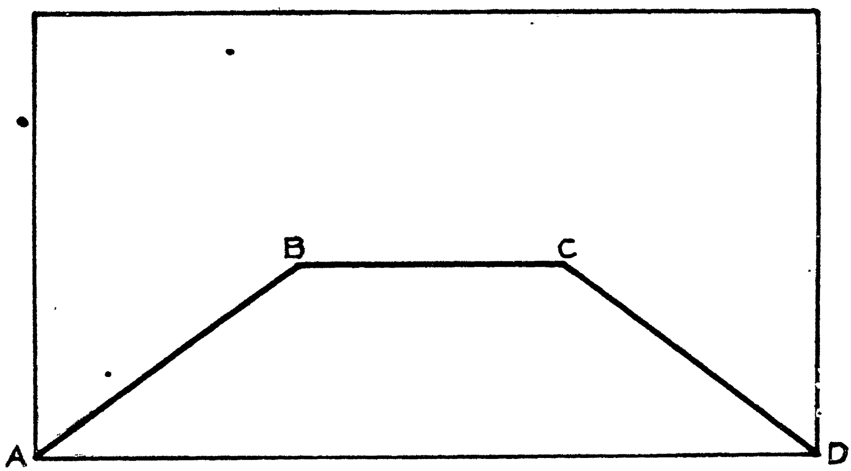

FIG. 26. STAGES OF INCREASE AND DECREASE IN HUMUS PRODUCTION

The A-B part of the figure represents the period of humus formation, during which humus is formed and no end products are developed. B-C indicates the stage in which there is a humic-decomposition process at work and end products are formed as rapidly as the humus is produced from the crude organic material. C-D represents the stage in which the humic-decomposition process is in the ascendancy and more end products are produced than there is humus formed.

for four and five months, respectively. The data given in table 1[2], from which the curves in figure 27 were obtained, show that more dry matter was added to each soil as the maturity of the manure increased; but the rate of increase of this dry matter added was, in general, less than the rate of increase of the humus formed.

It would seem that in the breaking down of the crude organic material of the soil into its end products, there occur a period of humus formation and a period of humus decomposition, involving three distinct steps which are illustrated in figure 26.

With this understanding of the process, the results shown in figure 27 may be explained. In all probability the earliest stages of maturity, the

[2]All tables are found in the appendix pages 159–169.

A stage, of the rye, oats, and buckwheat, in the 1916 series, had reached that phase of organic decay indicated by *C-D* in figure 26. The older materials, the *B* and *C* stages of the same crops, were still in the stage during which the production of humus and the development of the end products balance each other.

Where the period of incubation was shorter, as shown in figures 28 and 29, the most succulent material used as manure was probably well along

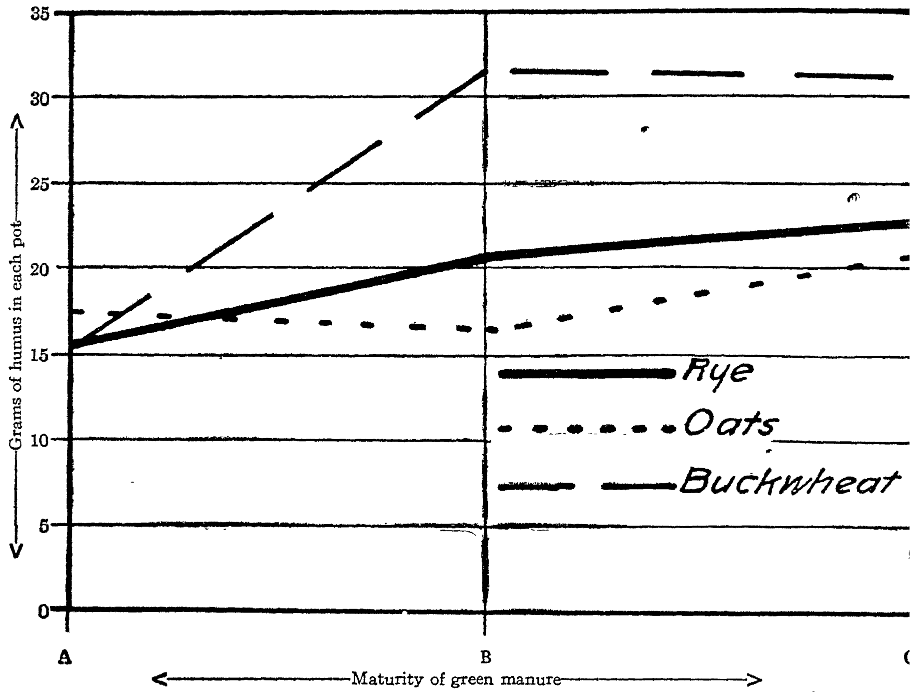

FIG. 27. SERIES 1916. EFFECT OF MATURITY OF GREEN MANURE ON AMOUNT OF HUMUS FORMED AT THE END OF TWELVE MONTHS

The weights of green material were constant
(Data given in table 1)

in the period represented by the *B-C* part of figure 26, while the materials added at their maturer stages were still in the period of humus formation.

In figure 28, the curve for buckwheat is a second exception to the original generalization — that the greater the succulency of the manure when incorporated with the soil, the larger is the amount of humus formed. This may be accounted for by the probability that the youngest and most succulent material incorporated had decomposed very rapidly and was in the period of humic decomposition at the time of the analysis.

It appears, from this study of the rate of humus formation, that the decomposition of the green-manure crop, when incorporated with the soil, is most rapid when the crop is at the half-mature stage, the early blossoming period. This applies to all the crops studied.

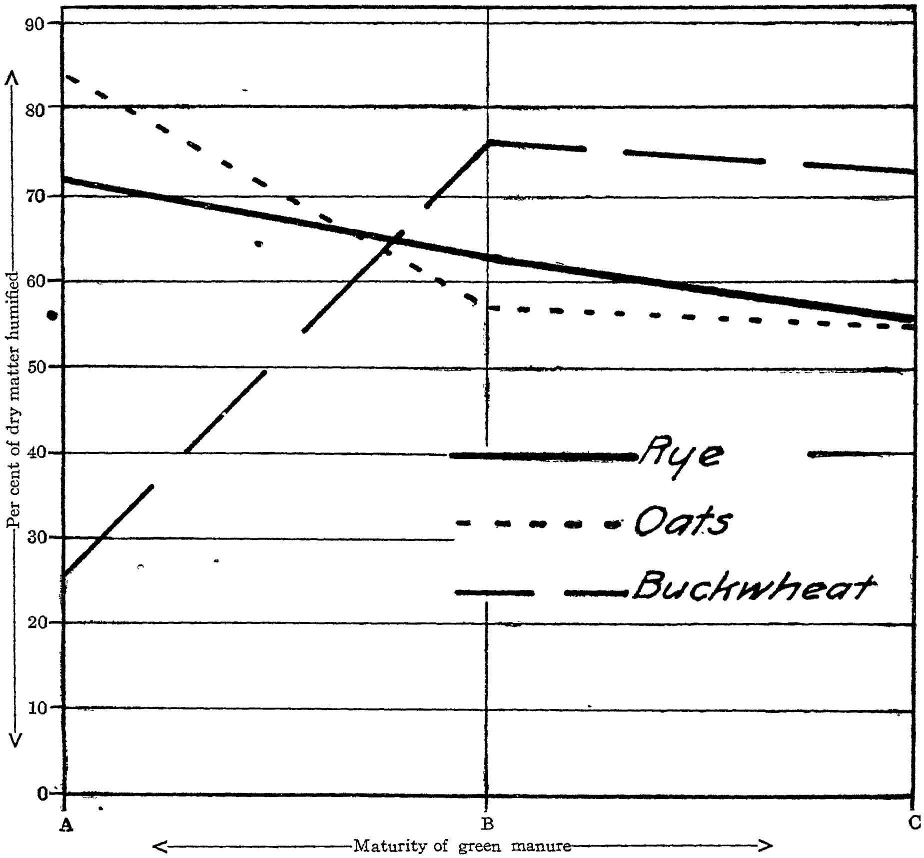

FIG. 28. SERIES 1917. EFFECT OF MATURITY OF GREEN MANURE ON PERCENTAGE OF DRY MATTER HUMIFIED AT THE END OF FOUR MONTHS

The weights of dry matter were constant
(Data given in table 4)

Effect of stage of growth of green manure on rate of nitrification in soil

As already stated, the accumulation of nitrates was also used as a measure of organic decay. The results of this method, as expressed in figures 30, 31, and 32, show that the process of nitrification goes on most vigorously with the most succulent material.

In figure 31, evidence of nitrification is lacking for rye and oats in the two later stages of maturity. It is unjustifiable to conclude, however,

that no nitrification has occurred, for evidence is given in table 2 and in the curves for humus (figures 27, 28, and 29) that some decomposition has taken place. It is probable that these two exceptions are due to the fact that nitrification has not become sufficiently pronounced to respond to the tests. Moreover, the nitrogen rendered available has perhaps been converted into some other form by the organisms of decomposition. This idea is supported by Gainey (1914), who shows that in using the

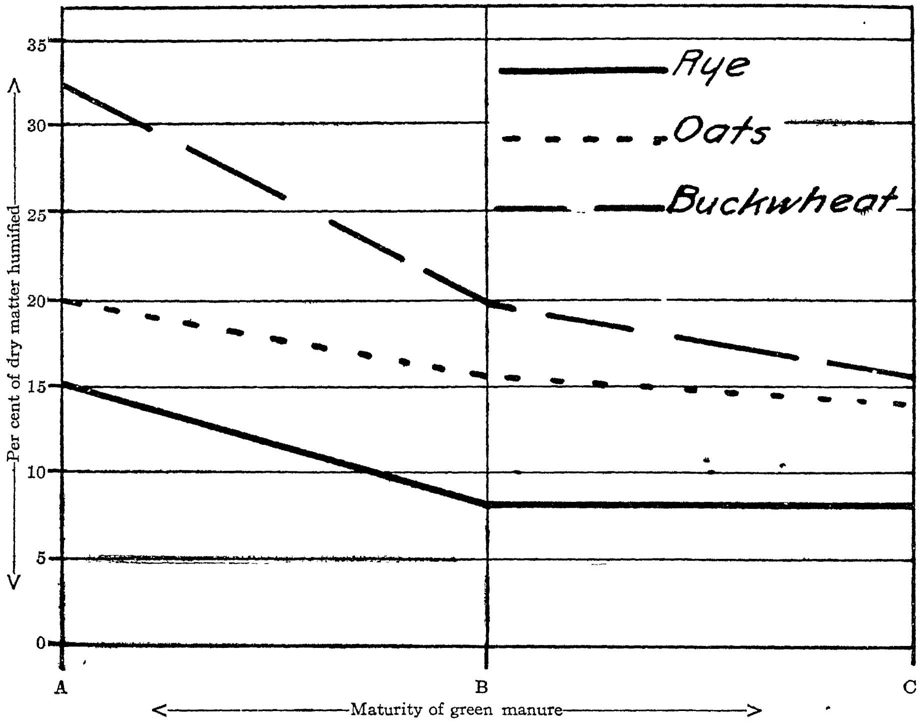

FIG. 29. SERIES 1918, EFFECT OF MATURITY OF GREEN MANURE ON PERCENTAGE OF DRY MATTER HUMIFIED AT THE END OF FIVE MONTHS

The green material at each stage came from equal soil areas, but were, of course, different in amounts (Data given in table 7)

accumulation of nitrates as a measure of the nitrifying power, one is confronted with the difficulty that the nitrates are sometimes used as a source of nitrogen by the saprophytic organisms of the soil.

In the curve for buckwheat in figure 30, the youngest material shows the least amount of nitrification as compared with the later stages of growth. In figure 31, the most succulent period, compared with the medium or *B*-stage, of maturity, indicates the same result. A physical examination of the soil itself, at the time of sampling for analysis, revealed that the

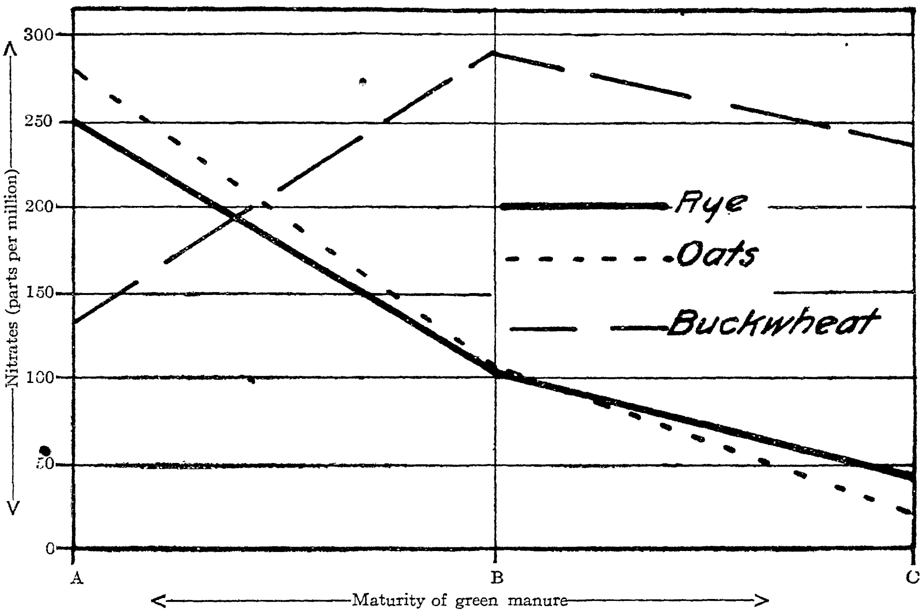

FIG. 30. SERIES 1916. EFFECT OF MATURITY OF GREEN MANURE ON AMOUNT OF NITRATES FORMED AT THE END OF TWELVE MONTHS

The weights of green material added to the soil were constant
(Data given in table 2)

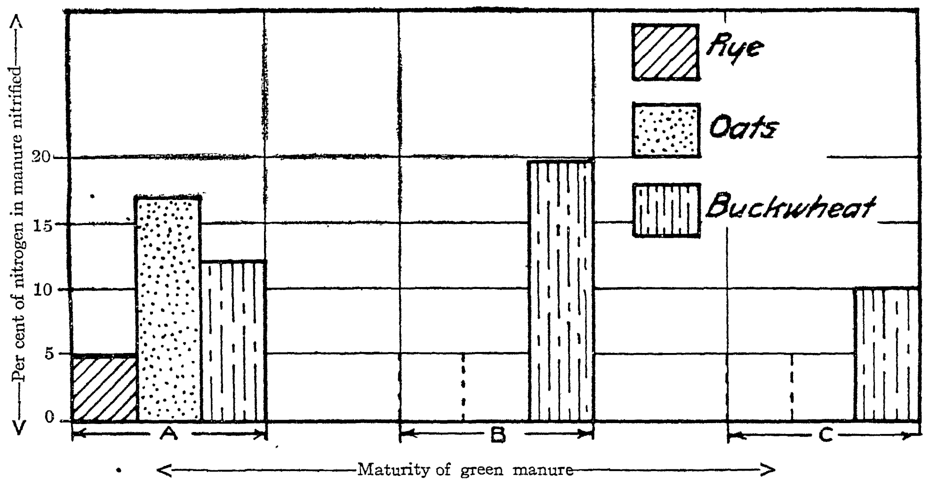

FIG. 31. SERIES 1917. EFFECT OF MATURITY OF GREEN MANURE ON NITRIFICATION PROCESS AT THE END OF FOUR MONTHS

The weights of dry matter added were constant
(Data given in table 5)

older material used for incorporation had not been fully broken down during the period of incubation. The soil containing the most succulent manure gave no physical evidence that organic matter was present, complete decomposition having apparently occurred.

The question arises as to what has happened to the nitrates in this stage of complete decay. As mentioned previously, Gainey (1914) has shown that the nitrates are used as a source of nitrogen by the saprophytic organisms in the soil. Doryland (1916) presents data showing the reduction

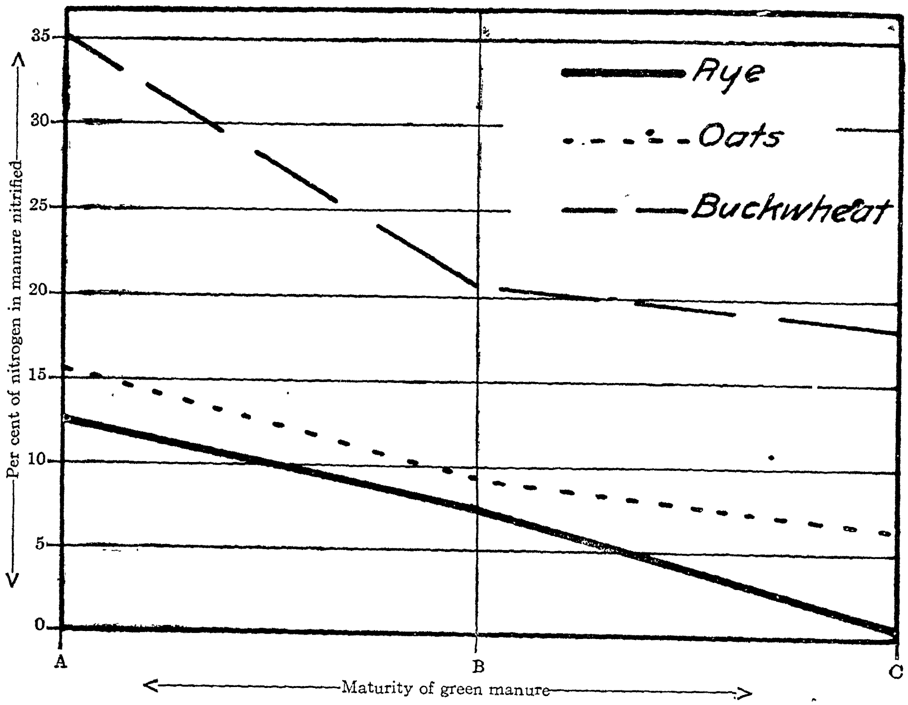

FIG. 32. SERIES 1918. EFFECT OF MATURITY OF GREEN MANURE ON NITRIFICATION PROCESS AT THE END OF FIVE MONTHS
The green manure at each stage came from equal soil areas
(Data given in table 8)

of nitrates in the soil to other forms of nitrogen, whereby no loss of nitrogen has occurred, as revealed by the analysis of the total nitrogen content of the soil. It is probable that the nitrates are utilized by the organisms present. In fact, the writer has found that the total number of organisms was much greater in the soil receiving the succulent buckwheat than in that to which material of a later stage of maturity had been added.

Conn (1901) claims that in the process of decay, nitrification does not occur until toward the end of the decomposition period. There is evi-

dently too great an accumulation of carbon dioxide at first to allow the nitrifying organisms to work. Nevertheless it is not probable that the nitrifying process is entirely eliminated. Altho it is possible for some nitrates to be produced continuously, they are probably utilized as fast as they are formed. Later, when the decomposition process slows up, the oxygen replaces the carbon dioxide and a favorable environment prevails for the nitrifying activities. It would appear, from this, that conditions particularly favoring the accumulation of nitrates are present at the later stages of decomposition. This supports the conclusion that plant tissue at the period of greatest succulency — the half-mature stage of green material — decomposes so readily when incorporated with the soil, that its nitrogen very quickly becomes available to the organisms that control nitrate formation.

Effect of stage of growth of green manure on increased availability of nutrients as measured by effect on subsequent plant growth

When crops were grown on soils previously treated with green manures of varying degrees of maturity, there was a marked stimulating effect. This was greatest with the most succulent additions, and was probably due to an increased availability of soil nutrients. The data on these results are shown diagrammatically in figures 33, 34, and 35.

The amount of dry matter added in the 1916 and 1918 series varied with the maturity of the manure used, the pots treated with the maturer material receiving the larger amounts of dry matter. In the 1917 series the dry matter was kept constant. This was done in order to learn whether the effects produced by increased maturity were due to increasing the amount of the dry matter, rather than to its lack of succulency. The effect seems to be the same in all cases. The crops produced for each unit of added dry matter decreased with the increased maturity of the additions. The younger the material when incorporated with the soil, the greater was the increase in crop growth.

Why does green manure of maximum succulency at the time of its incorporation with the soil produce the most beneficial effect on the growth of subsequent crops? It may be because of a more favorable effect on the physical condition of the soil. The manure in the succulent state undoubtedly decomposes very readily, and nutrients combined with the organic compounds of the tissues are very soon released, thus becoming available to the crop. The decomposition products may also react on the soil constituents and render them more readily available to the growing plants. Decomposition of organic matter in the soil appears to render available the essential nutrients in the soil. Jensen (1917) found increased

solubility of iron, calcium, magnesium, and phosphorus after alfalfa had been incorporated with the soil and allowed to decompose for six months. He found also that sweet clover, after decomposing for three months in the soil, increased the solubility of the phosphorus present from 30 to 100 per cent; and he states further that the amounts of available calcium, magnesium, iron, and phosphorus in citrus soils are measurably increased by the addition of decaying organic material. Hopkins and Aumer (1915) claim that the nitrite organisms associated with the decaying processes

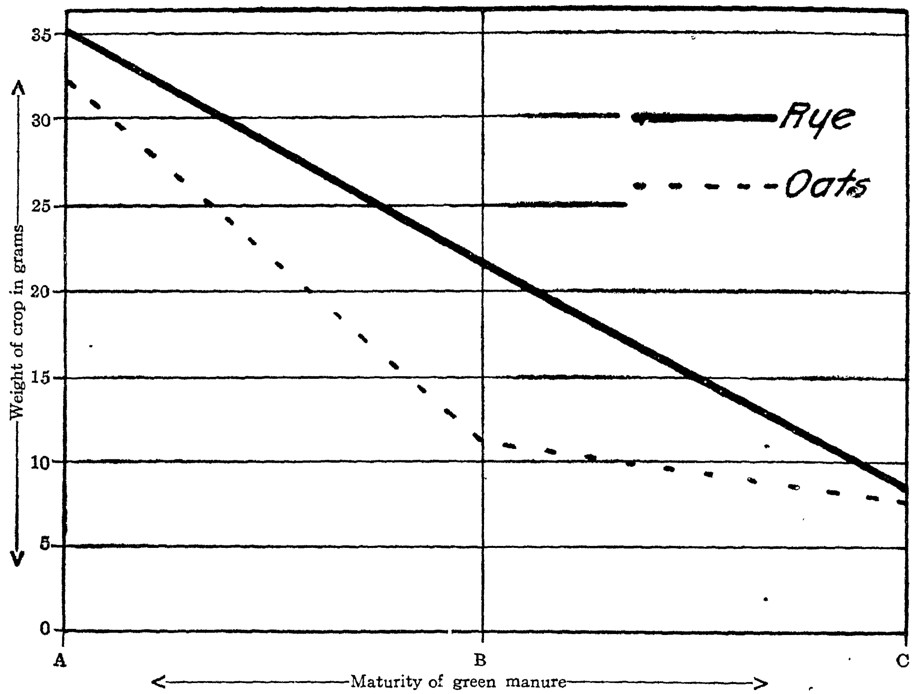

FIG. 33. SERIES 1916. EFFECT ON GROWTH OF A SUBSEQUENT WHEAT CROP PRODUCED BY THE INCORPORATION IN THE SOIL OF GREEN MANURE AT VARIOUS STAGES OF MATURITY AND THE SUBJECTION OF THE MIXTURE TO A TWELVE-MONTHS INCUBATION PERIOD

The weights of green material added were constant
(Data given in table 3)

render available the insoluble phosphorus in the soil. Hopkins and Whiting (1916) applied green manures to soil residues from which the soluble potassium had been extracted. Sufficient insoluble potassium was liberated thereby to enable clover to grow luxuriantly when treated with lime and phosphorus. Snyder (1897) treated soils with green manures, and after allowing fermentation to procced for one year he found

a considerable increase in the amount of available phosphorus and potassium in the soil humus. He attributes these results to the large amounts of carbon dioxide given off by the decaying organic matter, since this gas acts as a solvent on the minerals of the soil. Truog (1912) shows in his work that the availability of the insoluble compounds of phosphorus is due to the carbon-dioxide accumulations brought about by the decay of green manures.

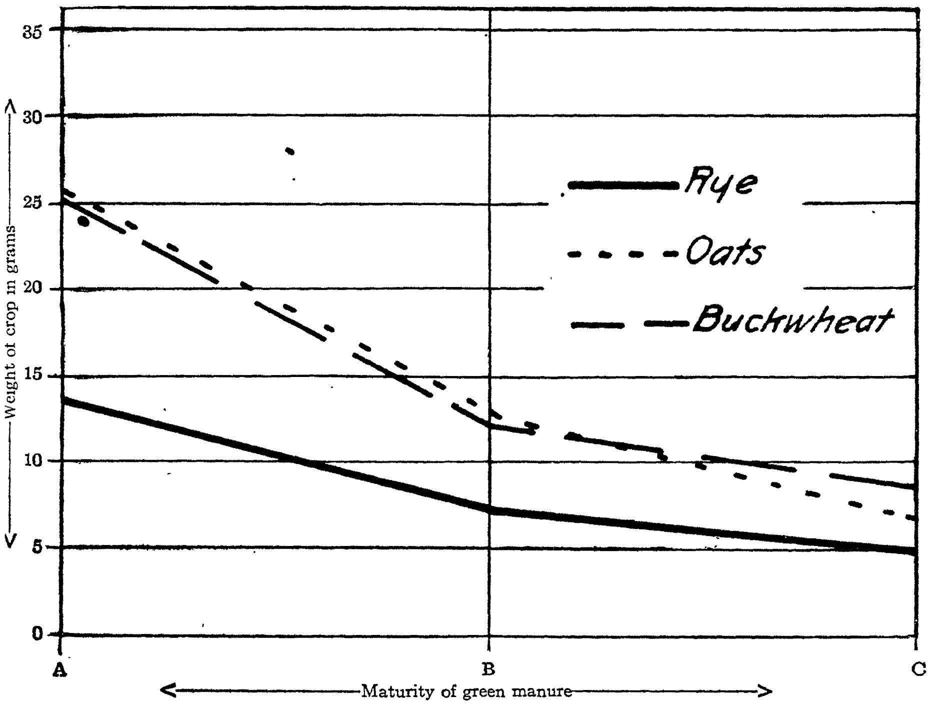

FIG. 34. SERIES 1917. EFFECT ON GROWTH OF A SUBSEQUENT WHEAT CROP PRODUCED BY THE INCORPORATION IN THE SOIL OF GREEN MANURE AT VARIOUS STAGES OF MATURITY AND THE SUBJECTION OF THE MIXTURE TO A FOUR-MONTHS INCUBATION PERIOD

The weights of dry matter added were constant
(Data given in table 6)

It would appear, therefore, that decaying organic matter renders available the otherwise insoluble plant nutrients in the soil. The decomposition products, such as carbon dioxide and butyric, acetic, lactic, and other organic acids, are in all probability the causative factors for much of this increase. The more rapid or more complete the decay process, the more quickly do the decomposition products accumulate, accompanied by an increased amount of available nutrients. As an

increase in the availability of the plant nutrients in soil may be measured by the growth of crops, it is reasonable to conclude, from the foregoing data, that the increased crop yields from the soils receiving the more succulent manure were due to an increase in the availability of the nutrients in the soil.

CONSIDERATION OF EXPERIMENTAL ERROR

In order to determine the degree of significance of the data just presented, and also to obtain a check on the accuracy with which the various analyses

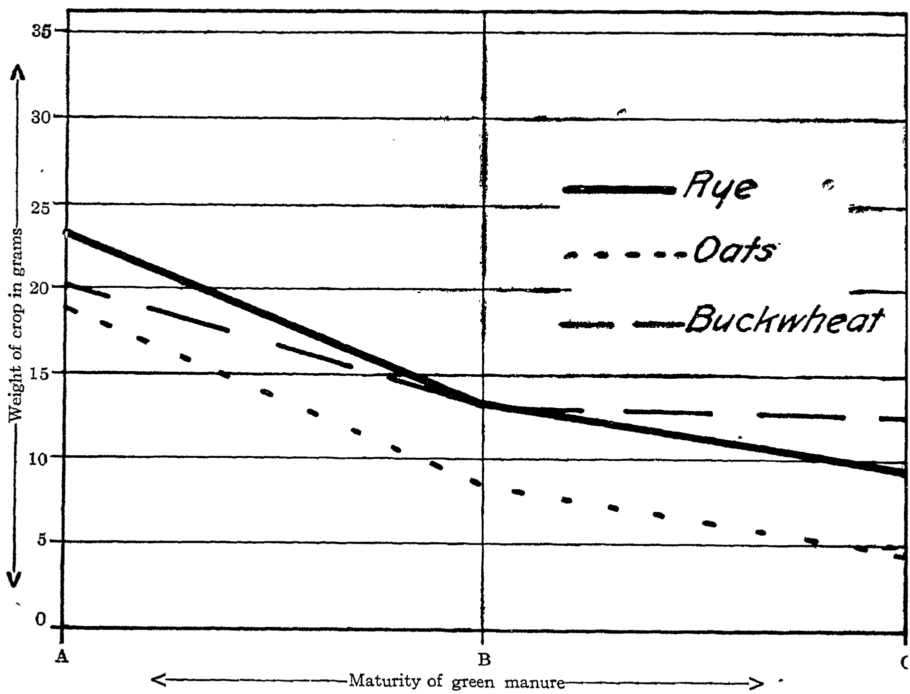

FIG. 35. SERIES 1918. EFFECT ON GROWTH OF A SUBSEQUENT WHEAT CROP PRODUCED BY THE INCORPORATION IN THE SOIL OF GREEN MANURE AT VARIOUS STAGES OF MATURITY AND THE SUBJECTION OF THE MIXTURE TO A FIVE-MONTHS INCUBATION PERIOD

The green manure at each stage came from equal soil areas
(Data given in table 9)

were performed, it was considered necessary to calculate the experimental error for the data obtained. This was done by finding the arithmetical mean values of the dry matter humified, of the nitrogen nitrified in the green manure, and of the total crop grown on the soils variously treated. The first two sets of means were expressed in percentages, the third in grams of dry matter produced. The probable error of these mean values

was then determined according to Peter's formula, as given by Mellor (1909). The formula is as follows:

$$R = \pm\ 0.8453 \frac{\Sigma(+v)}{n\sqrt{n-1}}$$

R represents the probable error; Σ $(+v)$ indicates the sum of the deviations of every observation from the mean, the sign of each deviation being disregarded; *n* denotes the number of observations actually made.

Before conclusions could be drawn as to the rate of decomposition of the green-manure crops, the following question was of necessity considered: Are the differences in the percentages of dry matter humified, in the grams of crop grown, and in the percentages of nitrogen nitrified in the green manure, in the variously treated pots, large enough to be significant? This question could be answered only by determining these differences and then calculating the probable error of each. The probable error was obtained by the use of the following formula:

$$E = \sqrt{E_1{}^2 + E_2{}^2}$$

In this formula E_1 and E_2 represent the probable errors of the values to be compared. Wood and Stratton (1910) state that such differences, to be significant, must be greater than 3.8 times the probable error. This would mean that the chances are thirty to one that such differences are due to treatment.

It is evident that the differences existing between the results obtained from pots treated with the most succulent manure and those from pots treated with manure at more advanced stages, are evidently greater than 3.8 times the probable error. Hence they are significant. In general, the differences existing between the two maturer stages, *B* and *C*, are not large. This is true not only for the humus data, but also for the nitrate and crop figures as well. It indicates that as the crops used for green manures approach maturity, the results show proportionately less benefit derived.

SUMMARY

The value of organic matter in soil is dependent on the ease with which it decays. The more rapidly it decomposes, the more quickly can it be used by the various agencies within the soil.

The greater the succulency of the crops used as green manures, the more quickly do they decay.

When crops are about half grown, they are at the point of maximum succulency. This is also the stage at which enough bulk has developed to create a fairly large increase in organic matter when the crop is incorporated with the soil.

Soils receiving incorporations of green manures at the half-mature stage, *A*, produced the largest crop yields when subsequently cropped.

Increasing amounts of dry matter added to a soil, in conjunction with increased maturity, have the same general effect on the humus formation, the accumulation of nitrates, and the crop growth, as does the addition of equal weights at each stage of increased maturity.

The more rapid the decomposition of green manures, the greater is the increase in the availability of plant nutrients in the soil, as shown by greater crop yields.

The younger the organic matter used, the larger is the percentage of total nitrogen present therein.

Nitrates accumulate at the greatest rate when green manures of maximum succulency are incorporated with the soil.

Some of the nitrates formed in the soil by the influence of green manure are probably utilized by growing organisms.

Nitrates do not accumulate in the soil until the green manures have become considerably decomposed.

The more readily the organic material is decomposed, the more rapidly does humus accumulate and the sooner does it break down to simple products.

The longer the period during which green manures are allowed to humify in the soil, the less is the amount of humus found in the soil on analysis.

There are apparently three periods in the humification of organic matter. In the first period humus alone is formed, thus allowing an accumulation in the soil. During the second stage humic decomposition sets in and the humus is reduced as rapidly as it is formed; accordingly no further accumulation is accomplished. In the third period, humus formation ceases and the only process at work is that of humus decomposition, resulting in a rapid decrease in the amount of humus in the soil.

Under the same conditions, rye and oats decay at approximately the same rate. Buckwheat, however, particularly in the maturer stages, decays much more readily than do rye and oats of corresponding maturity.

CONCLUSION

In these investigations, using as measurements the rapidity of humus formation, the accumulation of nitrates, and the increased availability of the plant nutrients, the subsequent crop growth proved that the greatest rapidity of decomposition and the greatest benefit to the soil were achieved by the use of green manures at the half-grown stage. This is true for all three of the green manures used in this series of experiments.

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APPENDIX

TABLE 1. SERIES 1916.* EFFECT OF MATURITY OF GREEN MANURE ON AMOUNT OF HUMUS FORMED AT THE END OF TWELVE MONTHS

Crop	Number of pot	Green manure (grams)	Dry matter added (grams)	Proportionate amounts of dry matter added (per cent)	Humus formed in 12 months	
					Total (grams)	Average (grams)
Rye .... A	1 2 3	181.5	30.9	100	14.56 16.25 15.84	15.55 ± 0.39
Rye .... B	1 2 3	181.5	40.0	129	22.55 19.44 20.60	20.86 ± 0.67
Rye C	1 2 3	181.5	53.0	171.5	25.10 21.80 21 40	22.77 ± 0.93
Oats .... A	1 2 3	181.5	38.6	100	18.77 19.64 14.36	17.59 ± 1.28
Oats .... B	1 2 3	181.5	38.5	99.7	15.09 16.45 18.32	16.62 ± 0.87
Oats C	1 2 3	181.5	39.1	101.6	22.50 20.03 19.33	20.62 ± 0.74
Buckwheat .... A	1 2 3	181.5	21.3	100	17.47 13.46 15.53	15.49 ± 0.80
Buckwheat .... B	1 2 3	181.5	36.2	170	34.17 32.60 28.35	31.71 ± 1.33
Buckwheat C	1 2 3	181.5	45.3	213	34.56 31 03 28.09	31.23 ± 1.32

* No checks were used with the 1916 series; hence the results will have to be interpreted in the light of this fact.

TABLE 2. SERIES 1916.* EFFECT OF MATURITY OF GREEN MANURE ON AMOUNT OF NITRATES FORMED AT THE END OF TWELVE MONTHS

Crop	Number of pot	Green manure (grams)	Dry matter added (grams)	Proportionate amounts of dry matter added (per cent)	Nitrates formed in 12 months: Total (parts per million)	Nitrates formed in 12 months: Average (parts per million)
Rye . . . . . A	1 2 3	181.5	30.9	100	248 260 252	253 ± 2.58
Rye . . . . . B	1 2 3	181.5	40.0	129	97.5 108 108	104 ± 2.58
Rye C	1 2 3	181.5	53.0	171.5	42 42 42	42 ± 0.00
Oats . . . . . A	1 2 3	181.5	38.6	100	270 290 280	280 ± 3.98
Oats . . . . . B	1 2 3	181.5	38.5	99.7	120 108 98	109 ± 4.58
Oats C	1 2 3	181.5	39.1	101.6	22 20 19	20 ± 0.59
Buckwheat . . . . . A	1 2 3	181.5	21.3	100	136 133 129	133 ± 1.39
Buckwheat . . . . . B	1 2 3	181.5	36.2	170	295 279 300	291 ± 4.92
Buckwheat C	1 2 3	181.5	45.3	213	243 238 230	237 ± 2.78

* No checks were used in the 1916 series.

TABLE 3. SERIES 1916.* EFFECT OF MATURITY OF GREEN MANURE INCUBATED IN SOIL FOR TWELVE MONTHS ON GROWTH OF A SUBSEQUENT WHEAT CROP

Crop	Number of pot	Green manure (grams)	Dry matter added (grams)	Proportionate amounts of dry matter added (per cent)	Crop to each unit of dry matter added (grams)	Straw crop (grams)	Grain crop (grams)	Total crop (grams)	Average crop (grams)
Rye......A	1 2 3	181.5	30.9	100	1.14	23.40 21.40 28.90	11.10 10.15 11.20	34.50 31.55 40.10	35.38 ± 1.87
Rye......B	1 2 3	181.5	40.0	129	0.543	12.30 18.50 17.70	4.80 4.50 7.40	17.10 23.00 25.10	21.73 ± 1.84
Rye......C	1 2 3	181.5	53.0	171.5	0.16	5.05 5.60 7.80	2.15 0.80 3.60	7.20 6.40 11.40	8.33 ± 1.19
Oats......A	1 2 3	181.5	38.6	100	0.847	22.97 23.40 23.80	6.53 11.10 10.30	29.50 34.50 34.10	32.70 ± 1.27
Oats......B	1 2 3	181.5	38.5	99.7	0.29	8.30 7.00 8.70	4.20 1.50 3.50	12.50 8.50 12.20	11.07 ± 1.02
Oats......C	1 2 3	181.5	39.1	101.6	0.20	7.19 4.80 5.60	0.91 2.40 2.60	8.10 7.20 8.20	7.83 ± 0.25

* No checks were used in the 1916 series.

TABLE 4. SERIES 1917. EFFECT OF MATURITY OF GREEN MANURE ON PERCENTAGE OF DRY MATTER HUMIFIED AT THE END OF FOUR MONTHS

Crop	Number of pot	Green manure (grams)	Dry matter added (grams)	Proportionate amounts of green manure (per cent)	Humus recovered from each pot (grams)	Humus due to treatment* (grams)	Dry matter humified: Total (per cent)	Dry matter humified: Average (per cent)
Rye.........A	1	181.5	56.3	100	44.70	40.46	72	72 ± 0.60
	2				46.20	41.96	74	
	3				43.00	38.76	71	
Rye.........B	1	180.0	56.3	99.1	41.50	37.26	66	63 ± 1.39
	2				38.00	33.76	60	
	3				40.10	35.86	64	
Rye.........C	1	150.0	56.3	83	36.50	32.26	57	56 ± 1.59
	2				37.42	33.18	59	
	3				33.10	28.86	52	
Oats........A	1	181.5	52.7	100	49.42	45.18	85	84 ± 1.79
	2				51.58	47.34	88	
	3				46.96	42.72	80	
Oats........B	1	181.5	52.7	100	33.92	29.68	56	57 ± 0.99
	2				33.50	29.26	55	
	3				35.44	31.20	59	
Oats........C	1	155.0	52.7	85.3	33.54	29.30	55	55 ± 0.59
	2				33.14	28.90	54	
	3				34.26	30.02	56	
Buckwheat...A	1	181.5	36.5	100	13.77	9.53	26	26 ± 1.79
	2				11.77	7.53	21	
	3				15.32	11.08	30	
Buckwheat...B	1	181.5	36.5	100	26.39	22.15	60	76 ± 6.17
	2				35.71	31.47	86	
	3				33.91	29.67	81	
Buckwheat...C	1	144.0	36.5	79.3	27.64	23.40	64	73 ± 5.67
	2				29.14	24.90	68	
	3				36.34	32.10	87	

* Untreated checks showed an average humus content of 4.24 grams to each pot.

TABLE 5. SERIES 1917. EFFECT OF MATURITY OF GREEN MANURE ON NITRIFICATION PROCESS AT THE END OF FOUR MONTHS

Crop	Number of pot	Green manure (grams)	Dry matter added (grams)	Proportionate amounts of green manure (per cent)	Nitrates in soil (parts per million)	Nitrates due to treatment* (parts per million)	Nitrogen added for each 100 grams of soil (milligrams)	Nitrogen in manure nitrified	
								Total (per cent)	Average (per cent)
Rye........A	1 2 3	181.5	56.3	100	172 181 187	87 96 102	...... 43.3	4.5 4.9 5.2	4.9 ± 0.13
Rye........B	1 2 3	180.0	56.3	99.1	62 69 60	....	...... 23.5	....	....
Rye........C	1 2 3	150.0	56.3	83	40 37 37	....	...... 18.3	....	....
Oats........A	1 2 3	181.5	52.7	100	262 258 267	177 173 182	...... 22.7	17.0 16.7 17.3	17.0 ± 0.14
Oats........B	1 2 3	181.5	52.7	100	62 65 69	....	...... 17.0	....	....
Oats........C	1 2 3	155.0	52.7	85.3	51 47 44	....	...... 12.2	....	....
Buckwheat..A	1 2 3	181.5	36.5	100	248 238 234	163 153 149	...... 27.9	12.7 12.1 11.5	12.1 ± 0.23
Buckwheat..B	1 2 3	181.5	36.5	100	297 305 298	212 220 213	...... 24.0	19.0 21.0 19.1	19.7 ± 0.51
Buckwheat..C	1 2 3	144.0	36.5	79.3	123 129 126	38 44 41	...... 9.0	9.8 10.2 10.0	10.0 ± 0.08

* Untreated checks showed an average nitrate content of 85 parts per million.

TABLE 6. SERIES 1917. EFFECT OF MATURITY OF GREEN MANURE INCUBATED IN SOIL FOR FOUR MONTHS ON GROWTH OF A SUBSEQUENT WHEAT CROP

Crop	Number of pot	Green manure (grams)	Dry matter added (grams)	Proportionate amounts of green manure (per cent)	Crop to each unit of dry matter (grams)	Straw crop (grams)	Grain crop (grams)	Total crop (grams)	Total crop due to treatment* (grams)	Average crop due to treatment (grams)
Rye..........A	1 2 3	181.5	56.3	100	0.24	9.20 10.01 14.05	4.4 4.5 5.6	13.60 14.51 19.65	11.30 12.21 17.35	13.62 ± 1.19
Rye..........B	1 2 3	180.0	56.3	99.1	0.13	4.10 4.90 7.55	4.1 3.9 4.1	8.20 8.80 11.65	5.90 6.50 9.35	7.25 ± 0.82
Rye..........C	1 2 3	150.0	56.3	83	0.09	1.90 4.25 3.60	3.2 4.1 4.4	5.10 8.35 8.00	2.80 6.05 5.70	4.85 ± 0.81
Oats..........A	1 2 3	181.5	52.7	100	0.48	20.00 19.00 21.20	7.6 7.1 8.7	27.60 26.10 29.90	25.30 23.80 27.60	25.57 ± 0.81
Oats..........B	1 2 3	181.5	52.7	100	0.25	8.60 16.85 7.60	4.1 5.2 3.3	12.70 22.05 10.90	10.40 19.75 8.60	12.92 ± 2.72
Oats..........C	1 2 3	155.0	52.7	85.3	0.14	8.10 6.70 4.35	2.1 3.4 3.1	10.20 10.10 7.45	7.90 7.80 5.15	6.95 ± 0.71
Buckwheat..........A	1 2 3	181.5	36.5	100	0.70	18.60 27.10 24.40	3.9 4.5 4.1	22.50 31.60 28.50	20.20 29.30 26.20	25.23 ± 2.00
Buckwheat..........B	1 2 3	181.5	36.5	100	0.34	9.00 15.10 9.70	2.7 3.6 3.0	11.70 18.70 12.70	9.40 16.40 10.40	12.07 ± 1.72
Buckwheat..........C	1 2 3	144.0	36.5	79.3	0.24	8.50 9.00 7.60	2.1 3.1 2.4	10.60 12.10 10.00	8.30 9.80 7.70	8.60 ± 0.47

TABLE 7. SERIES 1918. EFFECT OF MATURITY OF GREEN MANURE ON PERCENTAGE OF DRY MATTER HUMIFIED AT THE END OF FIVE MONTHS

The green material at each stage came from equal soil areas

Crop	Number of pot	Green manure (grams)	Dry matter added (grams)	Proportionate amounts of dry matter added (per cent)	Humus recovered from each pot (grams)	Humus due to treatment* (grams)	Dry matter humified: Total (per cent)	Dry matter humified: Average (per cent)
	1				11.16	4.43	12.2	
Rye.........A	2	181.5	36.3	100	14.58	7.85	21.6	15.3 ± 2.39
	3				11.14	4.41	12.1	
	1				12.44	5.71	7.3	
Rye.........B	2	323.0	78.0	215	13.07	6.34	8.1	8.3 ± 0.47
	3				14.12	7.39	9.5	
	1				16.72	9.99	6.6	
Rye.........C	2	366.0	150.0	413	19.90	13.17	8.8	8.1 ± 0.51
	3				20.02	13 29	8.8	
	1				13.93	7.20	21 0	
Oats.......A	2	181 4	34.4	100	13.81	7.08	20.0	20.0 ± 0 40
	3				13.12	6.39	19.0	
	1				15.69	8.96	14.1	
Oats........B	2	273.0	63.0	183	17.39	10 66	16.9	15.9 ± 0.53
	3				17.36	10 63	16.8	
	1				23.97	17.24	14.1	
Oats........C	2	350.0	122.0	355	23.38	16.65	13.9	14.0 ± 0.04
	3				24.03	17.30	14.1	
	1				17.00	10.27	38.0	
Buckwheat...A	2	181.5	27.2	100	14.93	8.20	30.0	32.4 ± 2.25
	3				14.63	7.90	29.1	
	1				19.82	13.09	18.9	
Buckwheat...B	2	345.0	69.0	254	19.52	12.79	18.5	19.7 ± 1.31
	3				21.62	14.89	21 6	
	1				21.03	14.30	14.3	
Buckwheat...C	2	400.0	100.0	368	24.33	17.60	17.6	15.8 ± 0.73
	3				22.16	15.43	15.4	

* Untreated checks showed an average humus content of 6.73 grams to each pot.

TABLE 8. SERIES 1918. EFFECT OF MATURITY OF GREEN MANURE ON NITRIFICATION PROCESS AT THE END OF FIVE MONTHS

The green material at each stage came from equal soil areas

Crop	Number of pot	Green manure (grams)	Dry matter added (grams)	Proportionate amounts of dry matter added (per cent)	Nitrates in soil (parts per million)	Nitrates due to treatment* (parts per million)	Nitrogen added for each 100 grams of soil (milligrams)	Nitrogen in manure nitrified: Total (per cent)	Nitrogen in manure nitrified: Average (per cent)
Rye........A	1 2 3	181.5	36.3	100	190 190 175	142 142 127	...... 24.0	12.56 12.56 12 20	12.44 ± 0.10
Rye........B	1 2 3	323.0	78.0	215	165 160 160	117 112 112	...... 33.5	7.40 7.30 7.30	7.30 ± 0.02
Rye........C	1 2 3	366.0	150.0	413	44 52 54	0 4 6	...... 66.0	0.00 0.06 0.06	0.04 ± 0.007
Oats........A	1 2 3	181.4	34.4	100	280 267 272	232 219 224	...... 26.0	15.80 15 40 15.70	15.63 ± 0 08
Oats........B	1 2 3	273.0	63.0	183	195 165 180	147 117 132	...... 28.8	9.45 9.10 9.35	9.30 ± 0.08
Oats........C	1 2 3	350.0	122.0	355	150 158 142	102 110 94	...... 37.0	6.23 6.35 6.05	6.21 ± 0.06
Buckwheat..A	1 2 3	181.5	27.2	100	400 385 415	352 337 367	...... 22.4	35.30 34.00 36.80	35.37 ± 0.17
Buckwheat..B	1 2 3	345.0	69.0	254	533 533 571	485 485 523	...... 52.0	20.00 20.00 22.40	20.80 ± 0.64
Buckwheat..C	1 2 3	400.0	100.0	368	460 440 492	412 392 444	..... 56.5	18.00 17.00 19.60	18.20 ± 0.55

* Untreated checks showed an average nitrate content of 48 parts per million.

Crop	Number of pot	Green manure (grams)	Dry matter added (grams)	Proportionate amounts of dry matter added (per cent)	Crop to each unit of dry matter (grams)	Straw crop (grams)	Grain crop (grams)	Total crop (grams)	Total crop due to treatment* (grams)	Average crop due to treatment (grams)
Rye.................A	1	181.5	36.3	100	0.64	24.0	2.5	26.5	22.2	23.4 ± 1.33
	2					28.6	2.4	31.0	26.7	
	3					23.6	1.9	25.5	21.2	
Rye.................B	1	323.0	78.0	215	0.17	17.1	0.9	18.0	13.7	13.2 ± 0.79
	2					14.3	1.2	15.5	11.2	
	3					17.1	1.9	19.0	14.7	
Rye.................C	1	366.0	150.0	413	0.07	11.2	1.8	13.0	8.7	9.4 ± 1.33
	2					9.0	2.0	11.0	6.7	
	3					15.1	1.9	17.0	12.7	
Oats................A	1	181.4	34.4	100	0.56	20.5	2.5	23.0	18.7	19.0 ± 0.45
	2					20.5	2.0	22.5	18.2	
	3					22.6	1.9	24.5	20.2	
Oats................B	1	273.0	63.0	183	0.13	11.4	1.6	13.0	8.7	8.5 ± 0.73
	2					9.5	1.5	11.0	6.7	
	3					12.7	1.8	14.5	10.2	
Oats................C	1	350.0	122.0	355	0.04	9.0	1.2	10.2	5.9	4.8 ± 1.09
	2					9.1	1.7	10.8	6.5	
	3					5.4	1.0	6.4	2.1	
Buckwheat..........A	1	181.5	27.2	100	0.74	20.3	2.3	22.6	18.3	20.2 ± 0.99
	2					21.4	2.4	23.8	19.5	
	3					24.0	3.0	27.0	22.7	
Buckwheat..........B	1	345.0	69.0	254	0.19	17.6	1.8	19.4	15.1	13.1 ± 0.83
	2					13.9	1.9	15.8	11.5	
	3					15.9	1.1	17.0	12.7	
Buckwheat..........C	1	400.0	100.0	368	0.13	18.2	1.3	19.5	15.2	12.9 ± 0.91
	2					15.9	1.2	17.1	12.8	
	3					13.2	1.8	15.0	10.7	

* Untreated checks showed an average total crop growth of 4.3 grams.

TABLE 10. COMPARISON OF THE AMOUNTS OF DRY MATTER HUMIFIED FROM CROPS INCORPORATED WITH SOIL AT DIFFERENT STAGES OF GROWTH*

(The first letter appearing on the left side of the column represents the greater percentage of humification. For the differences to be significant, they must be 3.8 times the probable error.)

Crop	Series 1917 (Data given in table 4)		Series 1918 (Data given in table 7)	
	Stages of growth compared	Difference (per cent)	Stages of growth compared	Difference (per cent)
Rye	A and B	9 ± 1.51	A and B	7.0 ± 2.43
	A and C	16 ± 1.67	A and C	7.2 ± 2.44
	B and C	7 ± 1.95	B and C	0.1 ± 0.69
Oats	A and B	27 ± 2.04	A and B	5.0 ± 0.90
	A and C	29 ± 1.87	A and C	6.0 ± 0.40
	B and C	2 ± 1.14	B and C	1.0 ± 0.80
Buckwheat	B and A	50 ± 6.45	A and B	12.7 ± 2.13
	B and C	3 ± 8.41	B and C	3.9 ± 1.49
	C and A	47 ± 5.93	A and C	16.6 ± 1.84

* No checks were used in the 1916 series; hence for that series no calculations could be made.

TABLE 11. COMPARISON OF THE AMOUNTS OF NITROGEN NITRIFIED IN CROPS INCORPORATED WITH SOIL AT DIFFERENT STAGES OF GROWTH*

(The first letter appearing on the left side of the column represents the greater percentage of nitrification. For the differences to be significant, they must be 3.8 times the probable error.)

Crop	Series 1917 (Data given in table 5)		Series 1918 (Data given in table 8)	
	Stages of growth compared	Difference (per cent)	Stages of growth compared	Difference (per cent)
Rye	....	....	A and B	5.11 ± 0.10
	....	....	A and C	12.40 ± 0.10
	....	....	B and C	7.29 ± 0.02
Oats	....	....	A and B	6.33 ± 0.11
	....	....	A and C	9.42 ± 0.10
	....	....	B and C	3.09 ± 0.10
Buckwheat	B and A	7.6 ± .55	A and B	14.57 ± 0.65
	B and C	9.7 ± .51	A and C	17.17 ± 0.57
	A and C	2.1 ± .24	B and C	2.60 ± 0.84

* No checks were used in the 1916 series; hence for that series no calculations could be made.

TABLE 12. COMPARISON OF THE AMOUNTS OF CROP GROWN ON SOILS THAT HAD BEEN TREATED WITH GREEN MANURES AT DIFFERENT STAGES OF MATURITY

(The first letter appearing on the left side of the column represents the greater amount of crop grown. For the differences to be significant they must be 3.8 times the probable error.)

Crop	Series 1917 (Data given in table 6)		Series 1918 (Data given in table 9)	
	Stages of growth compared	Difference (per cent)	Stages of growth compared	Difference (per cent)
Rye	A and B	6.37 ± 1.44	A and B	10.2 ± 1.54
	A and C	8.77 ± 1.44	A and C	14.0 ± 1.87
	B and C	2.40 ± 1.15	B and C	3.8 ± 1.54
Oats	A and B	12.65 ± 2.83	A and B	10.5 ± 0.85
	A and C	18.62 ± 1.06	A and C	14.2 ± 1.17
	B and C	5.97 ± 2.79	B and C	3.7 ± 1.30
Buckwheat	A and B	13.16 ± 2.63	A and B	7.1 ± 1.28
	A and C	16.63 ± 2.05	A and C	7.3 ± 1.34
	B and C	3.47 ± 1.77	C and B	0.2 ± 1.22

* No checks were used in the 1916 series; hence for that series no calculations could be made.

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Production of New Strains of Corn for New York

C. H. Myers, H. H. Love, and F. P. Bussell

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PRODUCTION OF NEW STRAINS OF CORN FOR NEW YORK [1]

C. H. MYERS, H. H. LOVE, AND F. P. BUSSELL [2]

The production of corn in New York has never reached the mark attained by some of the Corn Belt States, yet the value of the crop each year places it among the important crops of the State. In 1918 the value of the corn crop in New York was $51,660,000.[3] This was somewhat greater than the value of either the oat or the potato crop for that year, and a little less than half the value of the hay crop. These comparisons show the relative importance of corn in the agriculture of the State. In the reference just quoted, figures are given for 1913 which indicate that approximately half of the crop is cut green for the silo. Of the remaining part, which is matured for grain, about half is cut and shocked in the field, while the other half is cut and hauled to the barn for husking. While these figures are not absolute, they give a general indication of the method of disposal of the crop. No statistics are available concerning the relative amounts of flint and dent varieties produced, but observations would indicate an increase in the relative acreage of dent corn.

Up to the time of the beginning of this investigation no systematic corn breeding had been done in this State by this experiment station. It is true, however, that a considerable number of farmers have always practiced, and still continue to practice, some method of selection, which has often resulted in the production of local strains. Most of this work has been done with the flint varieties.

As the construction of silos increased, there was a larger use of dent varieties, since these generally give a greater yield per acre than do the flints. For the most part, this seed was obtained from the Middle West, where the season is better adapted to the growth of corn. Consequently, this corn in New York often failed to reach a stage of maturity sufficiently advanced even for ensilage. This state of affairs offered an opportunity for corn-breeding work with dent varieties, especially along the line of increased maturity.

VARIETIES PRODUCED

Three strains of corn have been produced as a result of the corn-breeding investigations described herein. Cornell 11 was derived from the variety

[1] Paper No. 79, Department of Plant Breeding, Cornell University, Ithaca, New York.

[2] The experiments herein reported were organized by Dr. H. J. Webber in 1908. In 1910 the work with Cornell 12, in Westchester County, was started by Dr H. H. Love. The work with Cornell 11 and Webber's Dent, in Cayuga and Saratoga Counties, respectively, was conducted by Dr. Webber until 1912, and after that it was in charge of Dr. C. H. Myers. The ensilage tests were conducted by Dr. F. P. Bussell.

[3] Yearbook of the United States Department of Agriculture, 1918, page 452.

Pride of the North. The breeding plat where it was developed was conducted in cooperation with E. W. Mosher, of Aurora, Cayuga County, New York. This strain is distinctly a Pride-of-the-North type. It gives a good yield of grain and a medium yield of stover. It matures regularly in Cayuga County and in other places of similar climatic conditions.

Webber's Early Dent was derived from Funk's Ninety Day, a mid-western dent, and has been produced in cooperation with G. R. Schauber, of Ballston Lake, Saratoga County, New York. Webber's Early Dent is also a yellow variety, but of an entirely different type from Cornell 11. It matures regularly in Saratoga County, where the season is rather short. Its yield of grain and stover is about like that of Cornell 11.

A third strain, Cornell 12, was produced in Westchester County, in cooperation with G. D. Brill, on the Seth Low farm at Bedford Hills. This strain, like Webber's Early Dent, was derived from Funk's Ninety Day. At the beginning of the third year's work with Webber's Early Dent, the corn from half of each of the seed ears planted in the Saratoga County plat in that year was taken to Westchester County to start the plat there. Cornell 12 is not markedly different in type from Webber's Early Dent. But owing to the length of the growing season in Westchester County, the former strain matures much later, requiring a season from ten days to two weeks longer. Under these conditions it is a heavier yielder, both in grain and in stover, than either of the other strains.

In obtaining these strains of corn, no new or unique methods have been devised. Some adaptations have been made in applying methods that have been in use for some time. Probably the following report of the methods and results of this work will be of value to the farmers of the State, as well as to experiment station workers in other States.

PRINCIPLES OF SELECTION

It may not be amiss to briefly summarize the principles underlying the modern conception of selection with respect to the practical problems involved. The earlier conception of the result of selection was that there was an accumulative effect, due to continued selection of individuals characterized by small differences caused by environment, which gradually tended to change the characteristics of the race. This idea was held by both plant and animal breeders.

Within recent years, however, as the result of carefully planned and executed experimental work, our understanding of the inheritance of acquired characters has been changed. Selection always seems effective in producing new strains or breeds. But a careful analysis, in the light of our present knowledge, shows that these results are attained through the isolation of strains which are already in existence in the general population of

the plants or animals with which we are working, but whose individuality is hidden in the mass until individual studies discover these differences. By selection, these individual strains are isolated and propagated, thus giving the impression of a change in the character of the race, when, as a matter of fact, it is merely the isolation of one of the component parts or strains.

This idea of selection is easily illustrated by the work with self-fertilized crops, such as wheat, oats, or barley. The cross- or open-fertilized crops, such as corn, do not illustrate this so readily, but a careful analysis, as will be shown later, proves that they also follow this principle.

METHODS USED

PLANTING

The well-known ear-to-row method was used in conducting all of these plats. In the beginning, 100 ears were chosen for each plat. From each ear an individual row was planted, usually from thirty to fifty hills long. Usually five kernels per hill were planted, and later, after the plants had become established, these were thinned to three stalks per hill. This series of 100 rows was repeated at least once, as a check against soil variation and other irregularities.

DETASSELING

Many experiments have been made to study the effect of inbreeding on corn, but no detailed description of these is given in this report. However, it may be stated as a demonstrated fact that inbreeding tends to reduce the vigor of corn to a considerable extent. As a result of continued inbreeding, a strain of corn reaches a point beyond which there is little, if any, further decrease in vigor. Such a strain is marked by its uniformity and its relatively low yielding capacity. The crossing of two such inbred strains immediately results in a striking restoration of vigor, sometimes greater than that of the original varieties from which the inbred strains were obtained.

A number of suggestions for corn-improvement work, based on these facts, have been made by different investigators. These suggestions have not been used in the work reported here, except in the avoidance of close inbreeding. To accomplish this, a system of detasseling alternate rows was practiced. An arrangement of planting was devised to simplify this procedure and to make it possible to have the seed of each parent ear produced in a detasseled row. In figure 36 is shown the general plan of planting for this purpose. In the plat there are 100 ear-rows and they are repeated once. In the first series, the ears are planted consecutively from 1 to 100. In the second series, ear no. 1 is planted end to end with

ear no. 50 of the first series, and ear no. 52 is planted end to end with ea no. 1 of the first series, and so on, as indicated in the diagram. Then beginning with the first row in the plat, alternate rows are detasselec straight through the whole plat. Thus, in the first series ear no. 1 is ii a detasseled row, while in the second series it is in a tasseled row. Fo convenience in harvesting and in note taking, the ears in the second serie are numbered as 101 to 200 to distinguish them from those in the firs series.

First Series	Second Series	
1 50 hills	152 50 hills	Detasseled
2	153	
3	154	Detasseled
4	155	
5	156	Detasseled
48	199	
49	200	Detasseled
50	101	
51	102	Detasseled
52	103	
97	148	Detasseled
98	149	
99	150	Detasseled
100	151	

FIG. 36. METHOD OF PLANTING AND DETASSELING

HARVESTING, AND SELECTION OF SEED

During the growing season, only general notes were taken concerning the growth and appearance of the individual rows. At harvesting time, each row was harvested separately and ears were reserved from each to be used as seed the following year. A large proportion of these reserved ears were never used as seed, since from 60 to 75 per cent of the rows were discarded each year. But the selections could not be made until the notes on the two series could be brought together and tabulated. From six to eight of the best ears from each row were therefore selected and were labeled with wire tags. Then, after the selection of ears from the best rows had been made, the remainder were discarded.

In making the selections of the best rows, and of the ears from these selected rows, no particular attention was paid to type. The only points taken into consideration were yield and maturity. It seemed more logical to make selections according to this standard, rather than according to some arbitrarily fixed score-card points, which might or might not be correlated with high yielding capacity. Therefore no effort was made to select toward any particular type. Measurements of all seed ears used in the different plats from year to year were made, however, and an analysis of these data is given elsewhere in this bulletin. Whatever the type of each of these three strains of corn may be now, it is the type that has come out of this selection in which yield and maturity were the only considerations. In this connection it should be said that with the Webber's Early Dent, in Saratoga County, the question of maturity was more important than it was with the Cornell 11, in Cayuga County; while with the Cornell 12, in Westchester County, the factor of maturity was not a very important one, because of the long growing season in that part of the State and also because the seed for starting this plat had already undergone a two-years selection for maturity.

SELECTION COEFFICIENT

Where maturity was a very important factor, as in Saratoga County, use was made of a selection coefficient, which combined both maturity and yield into a single expression. At harvest time each individual row was husked and the corn was weighed. The number of stalks, disregarding suckers, was also taken. From these data the average yield per stalk was computed. The ears were also sorted and counted as ripe and unripe. From these figures the percentage of maturity was computed. The yield per stalk was then multiplied by the percentage of maturity, to obtain the selection coefficient which was used in choosing the rows from which ears were to be taken for the following year's breeding plat. While this selection coefficient may have been obtained in a somewhat arbitrary manner,

it seemed to furnish a good method of combining both the quality of yield and that of maturity into one expression which could be used during the subsequent course of the work. In table 1 are given the data from the crop of 1909 in the Saratoga County plat, showing the use of the selection coefficient.

TABLE 1. DATA FROM SARATOGA COUNTY PLAT, CROP OF 1909

Row no.	Progeny no.	Number of stalks	Number of suckers	Total yield (pounds)	Yield per stalk (pounds)	Number of ripe ears	Number of unripe ears	Percentage of maturity	Selection coefficient (total yield multiplied by percentage of maturity)	Selection coefficient (yield per stalk multiplied by percentage of maturity)
1	3-9-1	73	3	50.5	0.693	19	53	26.4	13.33	0.183
2	3-15-1	56	16	42.5	0.759	19	30	38.8	16.49	0.294
3	3-21-1	74	2	48.0	0.649	30	40	42.9	20.59	0.278
4	3-22-1	71	3	51.5	0.725	18	47	27.7	14.27	0.201
5	3-27-2	75	3	44.0	0.586	21	44	32.3	14.21	0.189
6	3-31-1	74	5	53.5	0.723	11	60	15.5	8.29	0.112
7	3-32-1	75	2	51.0	0.680	19	52	26.8	13.67	0.182
8	3-33-1	73	3	43.5	0.596	24	40	37.5	16.31	0.223
9	3-34-1	71	3	50.0	0.704	13	57	18.6	9.30	0.131
10	3-35-1	74	2	47.0	0.635	23	43	34.9	16.40	0.222
11	3-37-1	72	2	44.0	0.611	17	51	25.0	11.00	0.153
12	3-40-1	74	2	48.0	0.649	25	43	36.8	17.66	0.239
13	3-42-2	75	3	45.0	0.600	13	53	19.7	8.87	0.118
14	3-43-1	72	6	47.0	0.653	37	30	55.3	25.99	0.361
15	3-46-1	71	2	39.5	0.556	14	36	28.0	11.06	0.156
16	3-47-1	69	5	52.0	0.754	20	50	28.6	14.87	0.216
17	3-49-1	73	5	51.0	0.699	18	50	26.5	13.52	0.185
18	3-64-1	75	3	42.5	0.567	21	42	33.3	14.15	0.189
19	3-61-1	72	4	50.0	0.694	27	40	40.3	20.15	0.280
20	3-60-1	72	4	39.5	0.549	27	30	47.4	18.72	0.260
21	3-50-1	68	8	46.0	0.676	4	55	6.8	3.12	0.046
22	3-67-1	73	2	36.0	0.493	13	36	26.5	9.54	0.131
23	3-75-3	70	4	41.5	0.593	16	41	28.1	11.66	0.167
24	3-80-1	74	7	45.5	0.615	29	34	46.0	20.93	0.283
25	3-90-1	75	0	46.0	0.613	23	46	33.4	15.36	0.205
26	3-94-2	70	2	42.5	0.607	24	38	38.8	16.49	0.236
27	3-95-1	70	4	49.0	0.700	7	59	1.1	0.52	0.008
28	3-9-2	72	9	50.5	0.701	29	37	43.9	22.17	0.308
29	3-21-2	72	5	44.5	0.618	19	46	29.2	12.99	0.180
30	3-22-2	68	8	47.5	0.699	42	26	61.8	29.36	0.432
31	3-27-3	66	4	44.0	0.667	16	47	25.4	11.18	0.169
32	3-31-2	74	5	52.5	0.709	41	30	57.8	30.35	0.410
33	3-32-2	73	9	51.5	0.705	10	57	14.9	7.67	0.105
34	3-33-2	62	4	39.5	0.637	26	24	52.0	20.54	0.331
35	3-34-2	72	2	48.5	0.674	30	39	43.5	21.10	0.293
36	3-35-2	73	3	49.0	0.671	20	44	31.2	15.29	0.209
37	3-37-2	70	6	43.5	0.621	22	36	37.9	16.49	0.235
38	3-40-2	69	6	46.0	0.667	19	40	32.2	14.81	0.215
39	3-41-1	72	5	47.5	0.660	31	32	49.2	23.37	0.325
40	3-42-4	68	8	46.5	0.684	13	49	21.0	9.77	0.144
41	3-43-2	73	5	51.0	0.699	59	15	79.7	40.65	0.557
42	3-46-2	73	6	48.5	0.664	50	19	72.5	35.16	0.481
43	3-47-2	73	5	44.5	0.610	35	36	49.3	21.94	0.301
44	3-49-2	75	4	41.5	0.553	30	29	50.9	21.12	0.281
45	3-50-2	73	4	46.0	0.630	37	32	53.6	24.66	0.338
46	3-60-2	75	5	49.5	0.660	34	37	47.9	23.71	0.316
47	3-61-2	72	10	49.5	0.688	51	20	71.8	35.54	0.494
48	3-64-2	71	5	49.5	0.697	44	30	59.5	29.45	0.415
49	3-67-2	74	5	49.0	0.662	20	50	28.6	14.01	0.189
50	3-90-3	73	4	35.5	0.486	39	16	70.9	25.17	0.345
51	3-95-2	70	3	41.0	0.586	21	37	36.2	14.84	0.212
52	3-15-2	73	5	39.5	0.541	29	31	48.3	19.08	0.261
53	3-21-3	74	1	43.5	0.588	30	35	46.2	20.10	0.272
54	3-22-3	72	2	45.5	0.632	38	29	56.7	25.80	0.358
55	3-27-4	73	0	39.0	0.534	19	40	32.2	12.56	0.172
56	3-32-3	74	3	44.5	0.601	44	21	67.7	30.13	0.407
57	3-33-3	67	7	42.5	0.634	24	37	39.3	16.70	0.249
58	3-34-3	72	7	44.5	0.618	34	28	54.8	24.39	0.339
59	3-35-3	68	6	37.0	0.544	11	36	23.4	8.66	0.127
60	3-37-3	74	2	37.0	0.500	22	26	45.8	16.95	0.226

TABLE I (*continued*)

Row no.	Progeny no	Number of stalks	Number of suckers	Total yield (pounds)	Yield per stalk (pounds)	Number of ripe ears	Number of unripe ears	Percentage of maturity	Selection coefficient (total yield multiplied by percentage of maturity)	Selection coefficient (yield per stalk multiplied by percentage of maturity)
61	3-41-2	70	2	37 5	0 536	13	50	20 6	7.73	0.110
62	3-43-3	74	1	44 5	0 601	36	31	53 7	23 90	0.323
63	3-46-3	73	1	43 5	0 596	27	33	45 0	19.58	0.268
64	3-47-3	74	0	47 0	0 635	36	28	56 3	26.46	0.358
65	3-49-3	72	2	48 5	0 674	27	40	40 3	19.55	0.272
66	3-50-3	72	5	47 5	0 660	38	28	57.6	27.36	0.380
67	3-60-3	70	5	43 0	0 614	26	40	39.4	16 94	0.242
68	3-61-3	74	4	38 0	0 514	40	24	62.5	23.75	0 321
69	3-64-3	72	0	44.0	0.611	32	32	50 0	22.00	0.305
70	3-95-3	75	4	43.5	0 580	23	44	34 3	14.92	0.199
71	3-67-3	74	2	46.0	0 622	30	39	43 5	20.01	0 271
72	3-15-3	74	1	40 5	0 547	29	33	46.8	18.95	0.256
73	3-32-4	72	4	51 5	0 715	29	43	40 3	20.75	0.288
74	3-34-4	74	0	43 5	0 588	36	28	56 3	24 49	0.331
75	3-35-4	72	2	45.0	0.625	30	34	46 9	21.10	0.293
76	3-37-4	73	2	37.5	0 514	32	26	55 2	20 70	0.284
77	3-50-5	73	2	42.0	0 575	24	41	36 9	15 50	0.212
78	3-60-4	75	2	39.0	0 520	37	27	57 8	22 54	0.301
79	3-61-4	73	2	42 0	0 575	28	35	44 4	18 65	0.255
80	3-64-4	73	3	32 5	0.445	13	32	28 9	9 39	0.129
81	3-67-4	73	1	37.0	0 507	6	47	11 3	4 18	0 057
82	3-95-4	73	4	43.0	0 589	23	40	36 5	15 70	0.215
83	3-34-5	71	5	47 5	0 669	14	54	20 6	9.79	0.138
84	3-32-6	74	4	47 0	0.635	16	54	22 9	10 76	0.145
85	3-37-7	74	7	45 0	0 608	5	53	8 6	3.87	0.052
86	3-41-4	73	1	45 5	0 623	18	43	29 5	13 42	0.184
87	3-46-4	74	4	47 0	0 635	34	22	60 7	28.53	0.385
88	3-47-4	73	2	42 5	0 582	35	20	63 6	27 03	0.370
89	3-49-4	74	9	43 0	0.581	19	40	32 2	13.85	0.187
90	3-64-5	62	2	31.0	0.500	27	12	69 2	21 45	0.346
91	3-32-7	74	6	50 5	0.682	12	59	16 9	8 53	0.115
92	3-34-6	75	3	39 0	0 520	19	45	29 7	11 58	0.154
93	3-35-6	74	1	39 5	0 534	7	47	13 0	5.14	0.069
94	3-37-9	72	3	37.5	0 521	18	32	36 0	13 50	0.188
95	3-41-5	73	0	39 0	0.534	6	46	11 5	4 49	0.061
96	3-46-5	74	2	31 5	0.426	19	20	48 7	15 34	0.207
97	3-47-5	75	3	49 5	0.660	21	47	30 9	15 30	0 204
98	3-95-5	74	3	40 5	0.547	17	41	29 3	11 87	0.160
99	3-64-7	74	2	41 0	0.554	29	30	49 2	20 17	0.273
100	3-64-6	71	1	41.5	0 585	18	39	31 6	13.11	0.185
101	3- 9-1	72	7	40 5	0.563	22	39	36 1	14 62	0.203
102	3-15-1	60	9	42 5	0 708	19	33	36 5	15 51	0 258
103	3-21-1	70	0	39 0	0 557	6	47	11.3	4.41	0 063
104	3-22-	73	4	40.5	0 555	15	40	27 0	10 94	0 150
105	3-27-2	74	1	36 0	0.486	17	43	28 3	10 19	0 138
106	3-31-1	72	2	40 0	0.556	7	56	11 1	4.44	0 062
107	3-32-1	75	1	44 5	0.593	10	55	15 4	6.85	0 091
108	3-33-1	74	1	41 5	0.561	20	47	29 9	12 41	0.168
109	3-34-1	73	4	46 5	0.637	11	56	16 4	7 63	0 104
110	3-35-1	72	4	41 5	0.576	10	57	14 9	6.18	0 086
111	3-37-1	73	2	38.0	0.521	10	51	16 4	6 23	0.085
112	3-40-1	72	8	41 5	0.576	5	59	7 8	3.24	0 045
113	3-42-2	75	3	34 0	0 453	3	40	7 0	2.38	0.032
114	3-43-1	75	5	41 5	0 553	21	48	30 4	12.62	0 168
115	3-46-1	73	4	40 5	0.555	8	44	15.4	6.24	0 085
116	3-47-1	72	8	43 5	0 604	3	60	4 8	2.09	0 029
117	3-49-1	74	4	44.5	0 601	17	42	28 8	12 82	0 173
118	3-64-1	74	7	39.5	0 534	16	54	22 9	9.05	0 122
119	3-61-1	75	4	41 5	0 553	14	48	22.6	9.38	0.125
120	3-60-1	73	4	45 0	0 616	27	39	40 9	18 41	0 252
121	3-50-1	75	8	46 5	0 620	2	61	3.2	1.49	0.020
122	3-67-1	73	0	38 5	0 527	5	54	8 5	3 27	0 045
123	3-75-3	67	1	33.0	0.493	1	42	2 3	0 76	0 011
124	3-80-1	73	5	44.5	0.610	13	50	20 6	9 17	0.126
125	3-90-1	74	3	39 0	0 527	13	46	22 0	8.58	0 116
126	3-94-2	72	3	42.5	0 590	2	59	3.3	1 40	0 019
127	3-95-1	73	13	44 0	0 603	6	57	9 5	4.18	0.057
128	3- 9-2	74	7	49 5	0 669	20	44	31 3	15.49	0 209
129	3-21-2	73	4	39.0	0 534	17	38	30 9	12 05	0.165
130	3-22-2	70	9	45.5	0.650	33	30	52 4	23.84	0.341
131	3-27-3	69	3	30 5	0.442	18	25	41.9	12 78	0 185

TABLE 1 (*concluded*)

Row no.	Progeny no.	Number of stalks	Number of suckers	Total yield (pounds)	Yield per stalk (pounds)	Number of ripe ears	Number of unripe ears	Percentage of maturity	Selection coefficient (total yield multiplied by percentage of maturity)	Selection coefficient (yield per stalk multiplied by percentage of maturity)
132	3-31-2	72	4	44.0	0.611	26	40	39.4	17.34	0.241
133	3-32-2	75	3	37.5	0.500	4	43	8.5	3.19	0.043
134	3-33-2	63	4	38.0	0.603	10	45	18.2	6.92	0.110
135	3-34-2	74	8	50.0	0.676	16	52	23.5	11.75	0.159
136	3-35-2	73	4	45.0	0.616	8	57	12.3	5.54	0.076
137	3-37-2	74	3	33.0	0.446	8	38	17.4	5.74	0.078
138	3-40-2	75	2	47.0	0.627	8	57	12.3	5.78	0.077
139	3-41-1	75	5	42.0	0.560	16	40	28.6	12.01	0.160
140	3-42-4	75	3	43.5	0.580	5	50	9.1	3.96	0.053
141	3-43-2	74	3	48.5	0.655	37	28	56.9	27.60	0.373
142	3-46-2	73	3	47.0	0.644	27	35	43.6	20.49	0.281
143	3-47-2	74	8	44.5	0.601	9	50	15.3	6.81	0.092
144	3-49-2	71	5	45.0	0.634	12	51	19.0	8.55	0.092
145	3-50-2	73	4	39.0	0.534	19	38	33.3	12.99	0.178
146	3-60-2	75	7	47.5	0.633	20	48	29.4	13.97	0.186
147	3-61-2	75	6	49.0	0.653	40	31	56.3	27.59	0.368
148	3-64-2	73	1	44.5	0.610	30	30	50.0	22.25	0.305
149	3-67-2	73	7	46.0	0.630	16	49	24.6	11.32	0.155
150	3-90-3	69	9	39.5	0.572	31	26	54.4	21.49	0.311
151	3-95-2	73	2	49.0	0.671	25	43	36.8	18.03	0.247
152	3-15-2	73	2	47.0	0.644	22	46	32.4	15.23	0.209
153	3-21-3	73	0	47.0	0.644	27	37	42.2	19.83	0.272
154	3-22-3	75	2	51.0	0.680	42	25	62.7	31.98	0.426
155	3-27-4	74	1	45.0	0.608	13	45	22.4	10.08	0.136
156	3-32-3	75	2	53.5	0.713	62	9	87.3	46.71	0.622
157	3-33-3	73	1	36.0	0.493	30	24	55.6	20.02	0.274
158	3-34-3	74	6	47.0	0.635	40	23	63.5	29.85	0.403
159	3-35-3	72	4	44.0	0.611	33	33	50.0	22.00	0.305
160	3-37-3	75	4	44.5	0.593	22	41	34.9	15.53	0.207
161	3-41-2	74	2	38.5	0.520	21	33	38.9	14.98	0.202
162	3-43-3	75	3	49.0	0.653	39	32	54.9	26.90	0.358
163	3-46-3	73	1	44.5	0.610	23	36	39.0	17.36	0.238
164	3-47-3	73	3	45.0	0.616	34	33	50.7	22.82	0.312
165	3-49-3	74	3	47.5	0.642	24	39	38.1	18.10	0.245
166	3-50-3	74	1	53.0	0.716	45	26	63.4	33.60	0.454
167	3-60-3	72	3	40.0	0.556	26	22	54.2	21.68	0.301
168	3-61-3	73	2	46.0	0.630	28	40	41.2	18.95	0.260
169	3-64-3	69	3	39.0	0.565	20	40	33.3	12.99	0.188
170	3-95-3	74	8	53.5	0.723	17	59	22.4	11.98	0.162
171	3-67-3	75	6	49.5	0.660	24	42	36.4	18.18	0.240
172	3-15-3	72	5	46.5	0.646	14	50	21.9	10.18	0.141
173	3-32-4	75	10	55.0	0.733	21	47	30.9	17.00	0.226
174	3-34-4	67	8	42.0	0.627	17	34	33.3	13.99	0.209
175	3-35-4	75	4	45.5	0.607	16	50	24.2	11.01	0.147
176	3-37-4	75	5	45.5	0.607	22	40	35.5	16.15	0.215
177	3-50-5	74	7	47.0	0.635	8	60	11.8	5.56	0.075
178	3-60-4	75	3	45.5	0.607	20	50	28.6	13.01	0.174
179	3-61-4	75	9	45.5	0.607	32	32	50.0	22.75	0.303
180	3-64-4	72	4	50.0	0.694	14	50	21.9	10.95	0.152
181	3-67-4	74	1	35.0	0.473	14	30	31.8	11.13	0.150
182	3-95-4	75	2	50.5	0.673	23	47	32.9	16.61	0.221
183	3-34-5	75	1	36.5	0.487	9	40	18.4	6.72	0.090
184	3-32-6	74	7	53.0	0.716	18	52	25.7	13.62	0.184
185	3-37-7	74	2	45.5	0.615	8	52	13.3	6.05	0.082
186	3-41-4	75	3	46.5	0.620	15	49	23.4	10.88	0.145
187	3-46-4	74	4	46.5	0.628	39	21	65.0	30.23	0.408
188	3-47-4	73	1	47.5	0.651	33	31	51.6	24.51	0.336
189	3-49-4	75	6	47.0	0.627	22	43	33.8	15.89	0.212
190	3-64-5	57	3	37.0	0.649	22	22	50.0	18.50	0.324
191	3-32-7	74	10	54.5	0.736	26	43	37.7	20.55	0.277
192	3-34-6	75	1	50.5	0.673	22	49	31.0	15.66	0.209
193	3-35-6	75	2	43.5	0.580	10	52	16.1	7.00	0.093
194	3-37-9	75	1	50.5	0.673	27	42	39.1	19.75	0.263
195	3-41-5	75	5	49.0	0.653	15	51	22.7	11.12	0.148
196	3-46-5	73	2	50.5	0.692	31	32	49.2	24.85	0.340
197	3-47-5	74	4	50.0	0.676	32	34	48.5	24.25	0.328
198	3-95-5	74	2	45.0	0.608	33	32	50.8	22.86	0.309
199	3-64-7	70	1	42.0	0.600	42	13	76.4	32.09	0.458
200	3-64-6	74	3	50.5	0.682	19	50	27.5	13.89	0.188

In the first two years of the work, the total yield per row, instead of the average yield per stalk, was used in obtaining a selection coefficient. There seems to be no particular advantage of either of these methods over the other, except, possibly, in the event of an uneven stand, when the coefficient obtained by using the average yield per stalk might be more reliable. In this work, however, all of the ears used for seed were carefully tested for germination. None but those showing a high percentage of germination were used. The planting was always made at a thicker rate than desired, and thinned to the proper stand. As a result, the stand in all of the plats was fairly uniform. A graphic comparison of these two coefficients, taken from the Saratoga County plat in 1909, is shown in figure 37 (page 219). There is such close agreement in these that either one might have been safely used. The one that was used, however, in making all of the selections, is the one obtained by multiplying the average yield per stalk by the percentage of maturity.

RESULTS OF THE WORK

INDIVIDUAL VARIATION

No improvement can be made in any selection work unless a certain amount of variation occurs within the group of plants where the selection is to be made. Strains of certain of the cereals which have descended from single individual parent plants — such as oats, for example — do not at all lend themselves to any improvement by selection, except that which may be accomplished by the initial selection, which results in the isolation of the so-called pure line. Corn, however, being open-pollinated, lends a different aspect to the case. The initial selection of the individual ear does not result in the immediate isolation of a pure line. It tends only to approximate this condition. There is, however, a marked difference in the individuality of rows grown from a number of ears selected at random. This is evidenced by the results obtained in these experiments, especially during the first few years of the work.

Variation in yield

The variation in the total yield of the rows planted from individual ears is interesting. A study of table 1 shows the individual variation, with respect to yield, in the crop of 1909. The results of other years might illustrate this point equally well, but it is neither feasible nor desirable to publish all the data. It will be noted that for this year the yield of individual rows ranged from 30.5 to 55 pounds, while the average yield per stalk ranged from 0.426 to 0.759 pound. As considered for each individual row there is close agreement between the total yield of that row

and the average yield per stalk. This is graphically represented in figure 38, in which the solid line represents the total yield per row, and the broken line the average yield per stalk. These two lines follow each other very closely.

In planting this plat for the year considered, the rows were replicated once. It is interesting to compare the two rows, in different parts of the plat, planted from the same ear. The relationship between the total yield and the average yield per stalk is so close here that it does not seem necessary to consider them individually. The results for the average yield per stalk are shown graphically in figure 39, in which the solid line represents the first hundred rows, and the broken line the second hundred. In general, these lines follow each other rather closely.

A graphic representation of the total yield per row from the Cayuga County plat for 1909, where each ear was twice repeated, is shown in figure 40, in which the solid line represents the first series, the broken line the second, and the dotted line the third,. There is very good agreement, especially with regard to the extremes. The scheme of planting was such that seed from the same ear was planted in different parts of the plat. Soil variation probably explains some of the divergence of the lines in these three figures.

Variation in maturity

The variation in the maturity of the individual rows was as evident as was that in the matter of yield. Again referring to table 1, it is seen that for that year and plat, the percentage of maturity ranged from 1.1 to 87.3. In figure 41 the maturity for the two different sets of rows is represented graphically. Here again the solid line represents the first hundred rows, and the broken line the second hundred. In general, there is close agreement between the two series of rows planted from the same individual ears.

It might be well here to call attention to the relationship between the two series of rows with respect to the selection coefficient. The results are represented graphically in figure 42. Since the yield per stalk and the percentage of maturity agree so well in the two series, it might be expected that there would be a correspondingly close agreement of the selection coefficients. In fact, there is good agreement between the two series of rows. The solid line represents the first series, and the broken line the second series.

INCREASED MATURITY

Maturity was a prime essential in adapting a dent corn for New York conditions. This was especially true for the work done in Saratoga County,

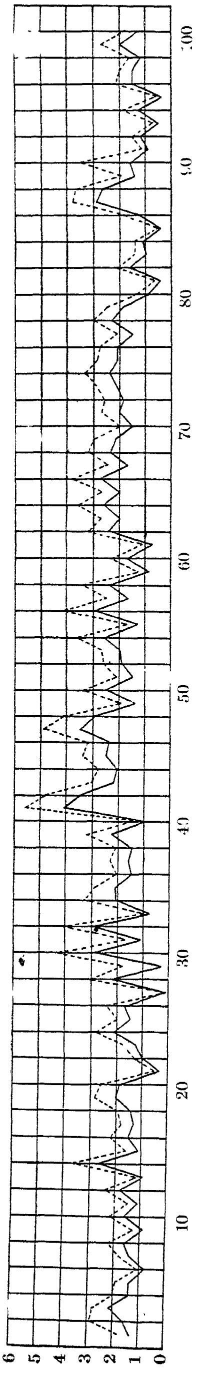

FIG. 37. COMPARISON OF THE TWO KINDS OF SELECTION COEFFICIENT

The solid line represents the coefficient for total yield and percentage of maturity; the broken line, that for average yield per stalk and percentage of maturity (Saratoga County plat, 1909 crop)

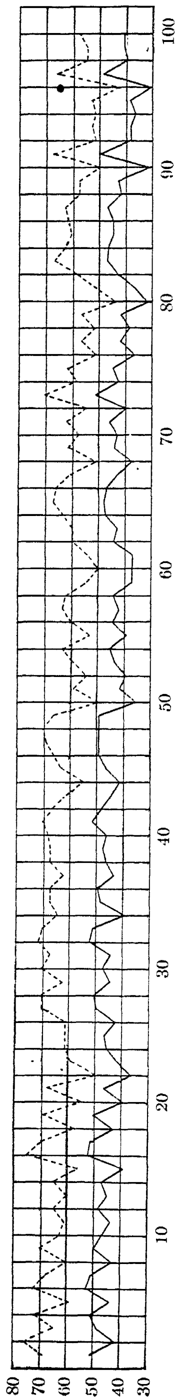

FIG. 38. RELATIONSHIP BETWEEN TOTAL YIELD PER ROW AND AVERAGE YIELD PER STALK

The solid line represents the total yield per row; the broken line represents the average yield per stalk (Saratoga County plat, 1909 crop)

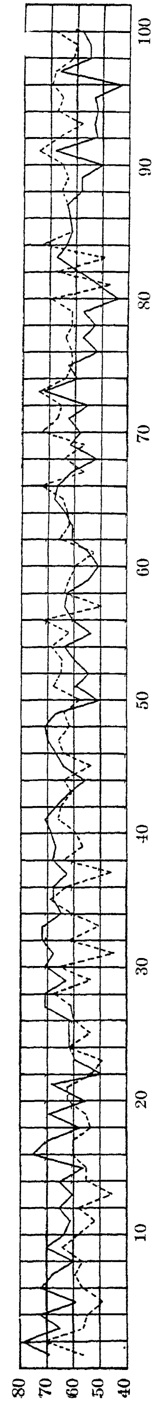

FIG. 39. AVERAGE YIELD PER STALK OF THE SAME PROGENIES PRODUCED IN DIFFERENT ROWS

The solid line represents the yield of the first series; the broken line, that of the second series (Saratoga County plat, 1909 crop)

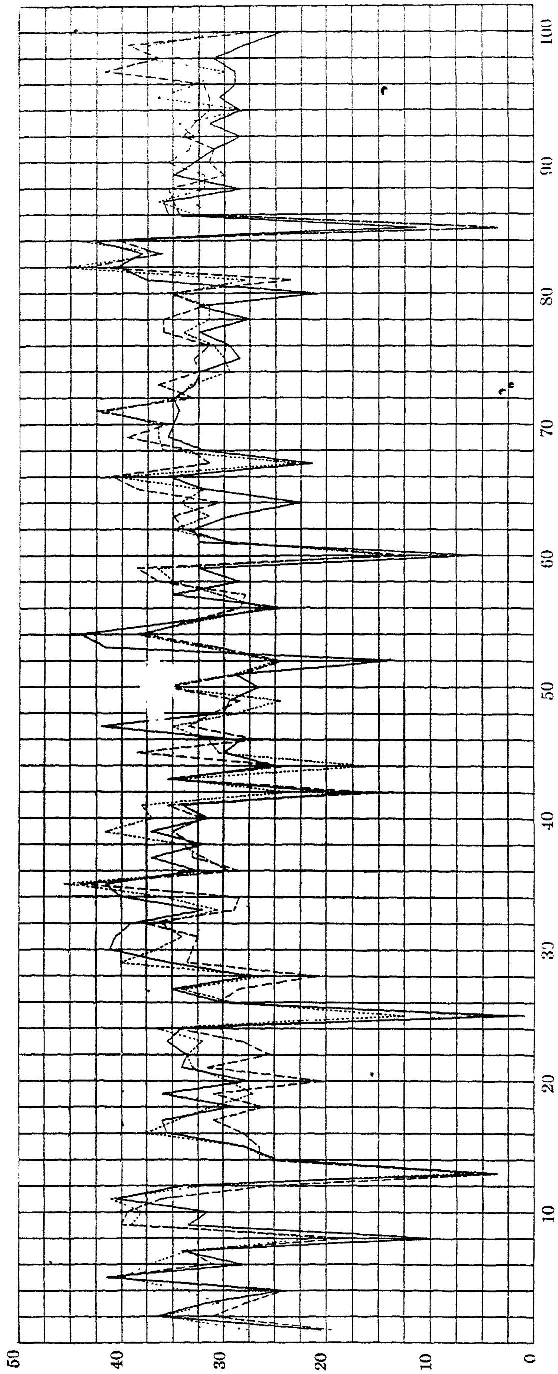

FIG. 40. TOTAL YIELD PER ROW OF THE SAME PROGENIES PRODUCED IN DIFFERENT ROWS

The solid line represents the yield for the first series, the broken line that for the second, and the dotted line that for the third (Cayuga County plat, 1909 crop)

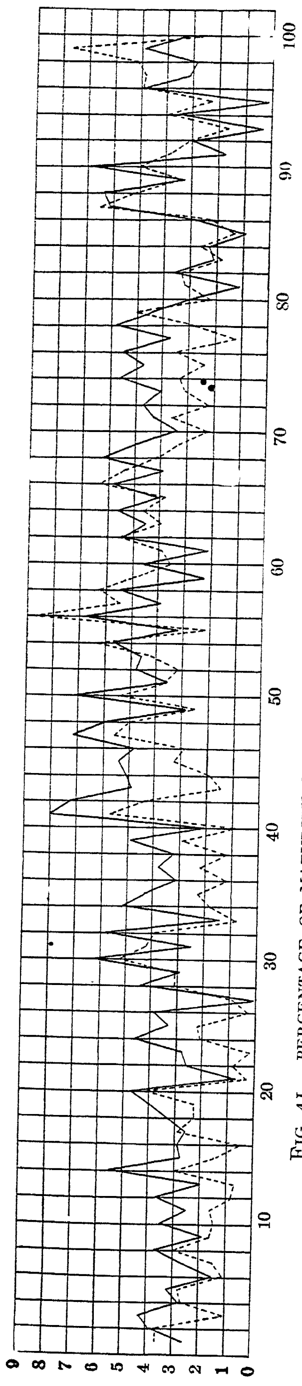

FIG. 41. PERCENTAGE OF MATURITY OF THE SAME PROGENIES PRODUCED IN DIFFERENT ROWS

The solid line represents the percentage of maturity of the first series; the broken line, that of the second series (Saratoga County plat, 1909 crop)

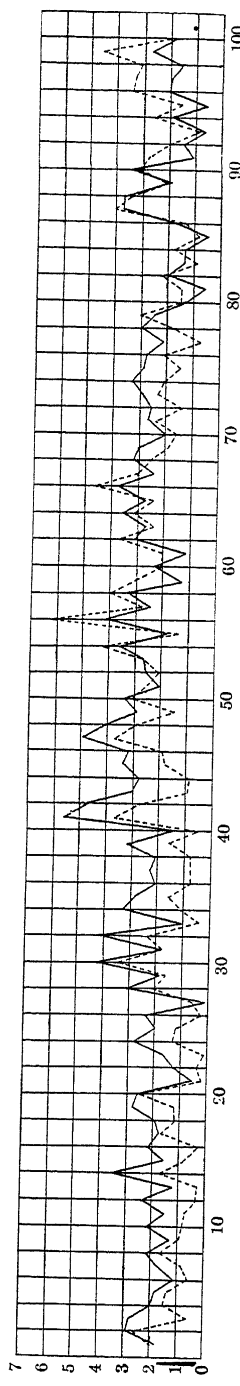

FIG. 42. SELECTION COEFFICIENTS FOR THE SAME PROGENIES PRODUCED IN DIFFERENT ROWS

The solid line represents the coefficient for the first series; the broken line, that for the second series (Saratoga County plat, 1909 crop)

where the average length of the growing season, between frosts, is 154 days,[4] the average date of the last spring frost being May 6 and that of the first fall frost October 7. In Cayuga County the average length of the growing season is 169 days, with the last spring frost usually about April 26 and the first fall frost averaging about October 12. The usual length of the growing season in Westchester County is 157 days, the average date of the last frost in the spring being May 3, and that of the first fall frost October 7.

From these data, it would seem that maturity would be of more importance in Westchester County than in Cayuga County. This is not true, however. In spite of the apparently shorter growing season, corn reaches a better state of maturity, on the average, in Westchester County than it does in Cayuga County. In Cayuga County, with the Cornell 11 strain, it was necessary to pay some attention to maturity. On the other hand, the Cornell 12 strain matured without difficulty in Westchester County. When these two strains were grown side by side, for comparison, in Cayuga County, a difference of about two weeks was found in their time of maturing.

As might have been expected, the most striking results for increased maturity were obtained in Saratoga County. The remnants of the original ears, with which the experiment was begun, were carefully saved and protected. During the course of the experiment, composite lots of grain from these ears were used as a check against the seed which had been subject to selection for a greater or lesser period of time. In each one of these comparative tests there was enough seed to plant from five to ten rows, usually fifty hills long. A composite sample of the selected ears for that season furnished the selected seed for the comparative tests. There were three such tests made, in 1911, 1912, and 1916, respectively.

In table 2 are given the results of the test of 1911, after three years of selection. From a study of the third column in this table, not much difference can be detected between the selected and the original seed as regards the average yield per stalk. But the fourth column shows a striking difference with respect to the maturity. The average percentage of maturity of the original seed is 13.2, while that of the selected is 71.9. This difference is brought out also in the fifth column, in which the selection coefficients of the different rows appear, and in figures 43 and 44, which are reproduced from photographs taken at the time of harvesting this plat.

[4] Wilson, Wilford M. Frosts in New York. Cornell Univ. Agr. Exp. Sta. Bul. 316: 505-543. (Reference on p. 541.) 1912.

FIG. 43. THE PRODUCT OF FIVE ROWS PLANTED WITH SELECTED SEED

Left-hand pile, ripe ears; right-hand pile, unripe ears
(Saratoga County plat, 1911)

FIG. 44. THE PRODUCT OF FIVE ROWS PLANTED WITH ORIGINAL SEED

Left-hand pile, ripe ears; right-hand pile, unripe ears
(Saratoga County plat, 1911)

TABLE 2. RESULTS FROM COMPARISON PLAT IN SARATOGA COUNTY, 1911

Row no.	Source of seed	Yield per stalk (pounds)	Percentage of maturity	Selection coefficient
11	Selected*	0.673	66.7	0.449
12	Original†	0.643	21.6	0.139
13	Selected	0.656	73.2	0.480
14	Original	0.708	4.8	0.034
15	Selected	0.690	77.5	0.535
16	Original	0.738	12.8	0.094
17	Selected	0.640	73.2	0.468
18	Original	0.677	9.7	0.066
19	Selected	0.690	77.3	0.533
20	Original	0.670	13.2	0.088
11a	Selected	0.649	65.2	0.423
12a	Original	0.655	29.7	0.194
13a	Selected	0.560	71.4	0.400
14a	Original	0.633	17.8	0.113
15a	Selected	0.490	69.2	0.339
16a	Original	0.602	6.7	0.040
17a	Selected	0.565	67.5	0.381
18a	Original	0.583	10.8	0.063
19a	Selected	0.600	77.5	0.465
20a	Original	0.594	5.1	0.030
Average	Selected	0.621	71.9	0.447
	Original	0.650	13.2	0.086

* Selected seed consisted of remnants of ears selected from the 1910 crop for the 1911 planting.
† Original seed was a mixture of grain from the remnants of the original seed from Illinois.

In 1912, five rows each of the selected and the original seed were planted. The results of this planting are given in table 3. The comparison here is more striking than the one of the preceding year, due to the fact that an early frost prevented any of the original seed from attaining maturity.

TABLE 3. RESULTS FROM COMPARISON PLAT IN SARATOGA COUNTY, 1912

Row no.	Source of seed	Yield per stalk (pounds)	Percentage of maturity	Selection coefficient
1	Selected	0.609	41.5	0.253
2	Original	0.776	0.0	0.000
3	Selected	0.554	56.7	0.314
4	Original	0.800	0.0	0.000
5	Selected	0.729	62.9	0.458
6	Original	0.875	0.0	0.000
7	Selected	0.650	63.8	0.415
8	Original	0.740	0.0	0.000
9	Selected	0.706	67.2	0.474
10	Original	0.743	5.4	0.040
Average	Selected	0.650	58.4	0.383
	Original	0.787	1.1	0.008

The average percentage of maturity from the selected seed for this year was 58.4, while that from the original seed was 1.1. A corresponding difference is noticeable in the selection coefficients.

In 1916 another comparison was made between the selected seed and the remnants of the original ears. There was enough of this seed left to plant several rows, and it is interesting to note that, although the seed was eight years old, there was a good germination under field conditions. A photograph of this plat taken during the growing season is reproduced in figure 45. There is a marked difference in the state of maturity,

FIG. 45. COMPARISON OF RESULTS FROM SELECTED AND FROM ORIGINAL SEED
The middle row is from the original seed; the rows on each side are from the selected seed (Saratoga County plat, 1916)

although the seeds were planted, of course, at the same time. At harvest time the corn from this plat was husked, the ears from each row were sorted into mature, medium, and immature, and the weights were determined and recorded. Samples were also retained for determining the loss in weight due to shrinkage. A summary of these results is given in table 4. It will be noted that 56.6 per cent of the ears from the selected seed were classified as mature, while only 1.1 per cent of the ears from the original seed were thus listed. This difference is further indicated by the greater shrinkage in the case of the corn from the original seed. A photograph which sharply contrasts the yields of these two lots of corn is shown in figure 46. In 1916 also a comparison was made between the Saratoga County strain and the Westchester County strain, that is, between

TABLE 4. SUMMARY OF RESULTS FROM COMPARISON PLAT IN SARATOGA COUNTY, 1916

(Percentages as classified according to maturity)

Source of seed	Mature	Medium	Immature	Percentage of shrinkage
Selected	56.6	33.6	9.8	38.4
Original	1.1	24.8	74.1	62.2

FIG. 46. COMPARISON OF YIELD FROM SELECTED AND FROM ORIGINAL SEED

Sorted from left to right into mature, medium, and immature ears. Upper row from selected seed, lower row from original seed

(Saratoga County plat, 1916)

Webber's Early Dent and Cornell 12. It should be recalled here that these had the same source up to 1910, when half of each of the seed ears used in the Saratoga County plat that year were taken to start the plat in Westchester County. There was no other exchange of seed. Several rows of each of these strains were planted in this comparison plat. The ears were sorted and weighed, as already described, and the percentages were computed on that basis. The summary of these results is given in table 5:

TABLE 5. COMPARISON OF WEBBER'S EARLY DENT AND CORNELL 12 IN SARATOGA COUNTY, 1916

(Percentages as classified according to maturity)

Variety	Mature	Medium	Immature
Webber's Early Dent	71.4	24.9	3.7
Cornell 12	34.5	54.3	11.2

There is a marked difference between these two strains with respect to maturity, 71.4 per cent of Webber's Early Dent being classed as mature as against 34.5 per cent for Cornell 12.

INCREASED YIELD

During the course of these experiments, there were no adequate checks provided for the purpose of determining whether or not the yield was being increased, except in so far as it was related to the question of maturity. With the Webber's Early Dent, in Saratoga County, this relationship was very close. In fact, the original corn, Funk's Ninety Day, with which this experiment was begun, never reached an adequate state of maturity for husking, and therefore, because of the great resultant loss by shrinkage, the yields from this original seed were always low in all of the comparative tests.

With the Cornell 11, in Cayuga County, the question of maturity was not so important after the first two years. With the Cornell 12, in Westchester County, there was little need for considering maturity, except for the first year, when a few progenies were discarded on the basis of immaturity. It should be borne in mind, however, that this last-named strain had undergone two years of selection in Saratoga County previous to its being taken to Westchester County. Therefore, in these two strains the selection was made mainly on the basis of yield. No remnants were available with which to make comparisons, as was done with the Webber's Early Dent. The subsequent comparisons of all three of these strains of corn in the ensilage tests, however, give an opportunity to judge their relative merits. The study of type, especially with respect to the size and weight of the ears, is also of value in this connection.

TRACING OF PEDIGREES

It has already been stated, in briefly summarizing the present-day conception of the effect of selection, that corn apparently does not conform to this principle, but that a careful analysis would show that individual selection for a period of years actually does tend to result in the isolation of lines which are component parts of the mixed race. The results of the three plats under consideration illustrate this very well.

In the beginning, 100 ears were used for planting the individual ear rows. There was marked variation in these, and, on the basis of this variation, selection was made. This selection was rigid enough so that not more than from 25 to 35 rows were chosen in any year. Enough seed ears were taken from the selected rows to plant the 100-row plat the following year. The results show that this led to the gradual elimination of

certain of the progenies from the original mother ears. In table 6 is given a list of the progenies remaining in the different plats when the individual ear-to-row selection was discontinued. At that time there remained five, six, and seven progenies, respectively, in Webber's Early Dent, Cornell 12, and Cornell 11. The progenies of all the other mother ears had been eliminated by the selection.

TABLE 6. PROGENIES REMAINING IN THE THREE PLATS WHEN INDIVIDUAL EAR-TO-ROW SELECTION WAS DISCONTINUED

Webber's Early Dent		Cornell 12		Cornell 11	
Progeny	Number of times appearing in 1912*	Progeny	Number of times appearing in 1915*	Progeny	Number of times appearing in 1914*
22	13	32	8	20	8
34	12	43	20	22	12
50	17	47	16	24	12
61	18	50	25	26	12
64	17	60	23	27	24
		64	8	32	12
				33	19

* Year in which the ear-to-row selection was discontinued

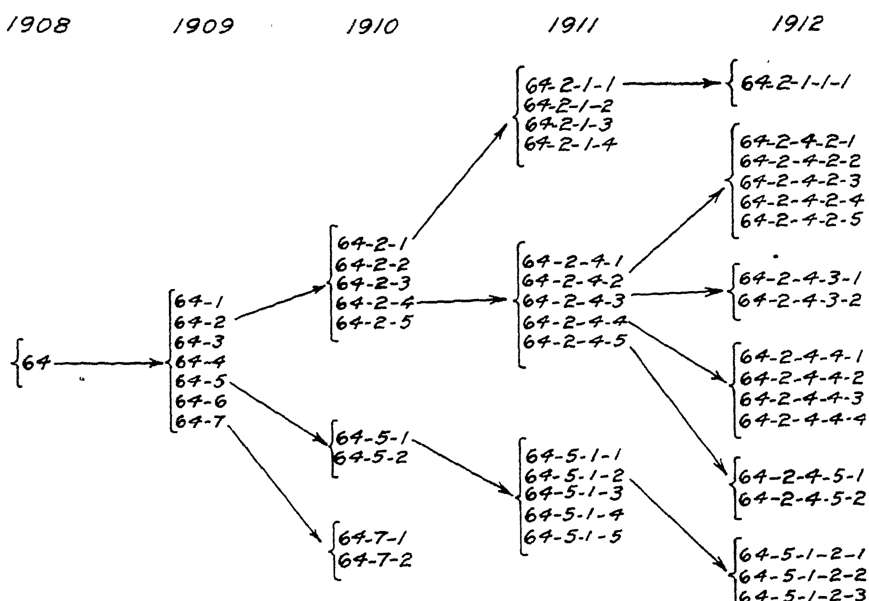

FIG. 47. TRACING THE PEDIGREE OF PROGENY 64 FROM THE SARATOGA COUNTY PLAT

These results are in accord with the pure-line concept. The selection from these three lots of corn has resulted in the isolation of types, not necessarily pure lines, which were present in the original population but whose identity could not be discovered until a study of individuals had been made.

This elimination and isolation may be readily seen by a study of figure 47, which traces the pedigree of progeny 64 from the Saratoga County plat and shows how selection acted in eliminating certain progenies. Space does not permit the tracing of all the progenies in this manner, but the pedigree record from the Saratoga County plat is summarized in table 7. This table includes only the more important progenies from this plat, but it serves to show how the elimination took place.

TABLE 7. ELIMINATION OF DIFFERENT PROGENIES BY SELECTION, SARATOGA COUNTY PLAT

(The figures in the columns under the different years represent the number of times each progeny appeared in the plat for that year)

Progeny	1908	1909	1910	1911	1912
9	1	2	1	0	0
15	1	3	5	3	2
21	1	3	5	4	0
22	1	3	11	23	13
31	1	2	3	2	2
32	1	6	10	3	4
34	1	6	4	3	12
43	1	3	7	5	0
46	1	5	8	12	6
47	1	5	14	7	9
50	1	4	4	14	17
61	1	4	8	9	18
64	1	7	9	15	17

THE USE OF MASS SELECTION

The practice of the individual ear-to-row method of selection over a period of years has resulted in the isolation of from five to seven progenies in each of the plats. Further selection might possibly have led to further elimination, but the differences between the various progenies were so small that the ear-to-row planting was discontinued and the progenies remaining in each plat were thrown together for planting. Since that time, mass selection has been practiced for the purpose of maintaining the three strains. This selection is made from a number of rows, usually in the middle of the field, which have been detasseled in order to insure cross-fertilization. The ears are chosen from the standing corn, special attention being given to the type as it has developed through the ear-to-

row selection. This method of selection has been practiced for four or five years now, and apparently is maintaining the strains. Of course, care has to be exercised to prevent mixture from other varieties growing in the vicinity. This problem, however, has caused but little trouble.

CORRELATION BETWEEN SEED-EAR CHARACTERS AND YIELD

In selecting the kind of ears to be used in a breeding plat, it is desirable to know, if possible, what kind will produce the most corn. Are the ears that grade well when judged by the score card the best ones to plant? In order to obtain some information on this subject, the data obtained in conducting these breeding plats were used to answer the following questions: To what extent are visible seed-ear characters correlated with yield? Are there certain characters indicative of high yield which should be kept in mind when seed is being selected? Are any of the seed-ear characters correlated with early maturity?

For use in these breeding plats, neither the longest, the shortest, the largest, nor the smallest ears were selected; instead, good, sound ears of high germinating power were chosen from the earliest, highest-yielding rows. In this way the extremes are not represented, although there is considerable variation in regard to the various other characters.

Since, as previously mentioned, the various seed-ear characters such as length, circumference, weight, number of rows of kernels, percentage of grain, and average weight of kernels, were taken, it is possible to determine whether any of these characters have any influence on the yield of grain. All the measurements were taken in centimeters, and all weights except that of the yield were taken in grams. The yield of each row was taken in pounds, and the yield per row was divided by the number of stalks in the row to obtain the average yield per stalk. The average circumference of the ear and the cob were obtained by averaging the tip and butt circumferences. The ratio of the tip circumference to the butt circumference was computed by dividing the tip circumference by that of the butt. In this way the shape of the ear was determined, for, the lower this ratio, the more tapering would be the ear. The average weight of kernels was determined by first ascertaining the number of kernels per ear (calculated by multiplying the number of kernels per row by the number of rows on the ear) and then dividing the weight of grain by the number of kernels. The average length and width of kernels was determined by taking the measurements of ten kernels and averaging these measurements. The percentage of grain was calculated by dividing the weight of shelled corn by the weight of the ear.

As these plats were planted by the ear-to-row method, it is possible to correlate the various characters of the seed ear with the yield and matur-

ity. Instead of using the yield per row to represent the yield, it was thought best to use the yield per stalk, calculated as outlined above. This seems to show the value of the ears, as to yield, more accurately than does the yield per row, since it takes into account the difference in stand which may exist. It does not correct this entirely, but only to a certain extent. When yield is mentioned in connection with these correlation studies, the yield per stalk is meant.

In order to determine the influence of any one character on yield, the data were arranged in a correlation table, in which the character in question was used as subject and the yield per stalk as relative. For example, in table 8 is shown the correlation between the length of the seed ear and the yield per stalk for the Webber's Early Dent variety, in 1909. The

TABLE 8. CORRELATION BETWEEN LENGTH OF SEED EAR AND YIELD PER STALK FOR WEBBER'S EARLY DENT, 1909

Length of seed ear (centimeters)	Number of ears, classed according to yield of grain per stalk in pounds										Total number of ears, classed according to length of seed ear
	.46-.49	.49-.52	.52-.55	.55-.58	.58-.61	.61-.64	.64-.67	.67-.70	.70-.73	.73-.76	
18-19....	.....	....	.....	.....	.....	.....	1	.....	.....	.....	1
19-20....	....	....	.....	5	2	1	.....	.....	.....	.....	8
20-21....	1	.....	3	6	4	3	4	1	.....	.....	22
21-22....	.....	.....	2	4	4	9	2	1	.....	.....	22
22-23....	.....	1	2	.....	4	2	6	2	.....	.....	17
23-24....	.....	.....	.....	2	3	3	1	3	1	.....	13
24-25....	.....	.....	.....	3	5	2	2	2	1	1	16
25-26....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Total number of ears, classed according to yield of grain per stalk....	1	1	7	20	22	21	16	9	2	1	100

Length of seed ear, subject; yield per stalk, relative. Correlation = 0.300 ± 0.061.

ear lengths were taken in centimeters and the ears were classified accordingly. The horizontal lines of figures in the table represent the number of seed ears in each class. The yield per stalk is expressed in fractions of a pound, and the perpendicular columns of figures thus represent also the number of rows falling in each class, the number of seed ears and the number of rows being necessarily the same in the ear-to-row method. For example, there are twenty-two rows in which the average stalk yields between 0.58 and 0.61 pound. It will be seen that there is great variation in the size of the ears, and therefore considerable variation in the type of ear planted. The arrangement of such data in a correlation table is a

very good way to express the results found, as it brings before the eye at a glance all of the results. The correlation here is 0.300 ± 0.061.

In table 9 is shown the correlation between the weight of the ear and the yield for Cornell 11, for 1909. The weight of the seed ear is here used

TABLE 9. CORRELATION BETWEEN WEIGHT OF SEED EAR AND YIELD PER STALK FOR CORNELL 11, 1909

Weight of seed ear (grams)	Number of ears, classed according to yield of grain per stalk in pounds								Total number of ears, classed according to weight of seed ear
	.46–.49	.49–.52	.52–.55	.55–.58	.58–.61	.61–.64	.64–.67	.67–.70	
260–280	.....	.....	....	....	1	1	....	.....	2
280–300	.....	1	1	5	10	10	2	.....	29
300–320	3	.....	.....	4	5	5	3	2	22
320–340	2	1	.....	2	4	5	3	3	20
340–360	.....	.....	1	.....	.....	.....	2	1	4
Total number of ears, classed according to yield of grain per stalk	5	2	2	11	20	21	10	6	77

Weight of seed ear, subject, yield per stalk, relative. Correlation = 0.094 ± 0.076.

as subject, while the yield per stalk is used as relative. Here the correlation is 0.094 ± 0.076, which shows that in this particular case the weight of the seed ear did not have any influence on the yield, although the seed ears varied greatly in weight.

These two correlation tables show how the data were handled. Similar tables were made for the other characters for each year. It is not necessary to give all these correlation tables here; it is sufficient to present the tables giving the correlation coefficients for the various plats.

As mentioned previously, this breeding work was conducted at three places and with two types of corn. The Pride-of-the-North type, later called Cornell 11, gave the results shown in table 10:

TABLE 10. CORRELATIONS BETWEEN SEED-EAR CHARACTERS AND YIELD PER STALK FOR CORNELL 11, 1909 AND 1910

Characters of seed ear correlated with yield per stalk	Coefficient of correlation	
	1909	1910
Length	−0.099±0.076	0.241±0.064
Weight	0.094±0.076	0.015±0.068
Number of rows	0.260±0.072	−0.127±0.067
Average weight of kernels	....	0.028±0.068
Ratio of tip circumference to butt circumference	....	−0.162±0.066
Percentage of grain	....	−0.177±0.066

When these correlation coefficients are considered, the fact must be kept in mind that a positive value for the coefficient shows that as the value for one character increases, so also does the value for the other character increase. The higher the coefficient in relation to its probable error, the more significant are the results. When a coefficient is negative — that is, preceded by the minus sign — then it signifies that as the value for one character increases, that for the other decreases. A coefficient of correlation never can be more than +1 or −1. Furthermore, it is generally considered that for a coefficient to be significant it should be at least from three to four times its probable error. This may be explained further by referring to table 8, which shows the correlation between the length of the seed ear and the yield per stalk for Webber's Early Dent in 1909. The correlation coefficient is 0.300, which is nearly five times the probable error, 0.061, indicating that the longer ears tend to produce plants giving a high yield per stalk. If such values were consistently obtained for this character, the conclusion that the longer ears are better seed ears would be justified.

From the data in table 10, it is clear that there are only two coefficients which are really significant — that for length of seed ear and yield for 1910, and that for the number of rows and yield for 1909. Since in each case the data for the same characters for the other year do not give the same results, it is doubtful whether they signify any definite relation. All of the other correlation coefficients are so small that they do not show any significant relation between the seed-ear characters and yield.

The results of the correlation studies on Webber's Early Dent for the years 1909 to 1912, inclusive, are given in table 11. From the data in this table, it is clear that the length of the seed ear does not indicate higher yielding ability, with the possible exception of the year 1909. However, since the constants are not consistent it does not appear that the length of

TABLE 11. CORRELATIONS BETWEEN SEED-EAR CHARACTERS AND YIELD PER STALK FOR WEBBER'S EARLY DENT, 1909 TO 1912

Characters of seed ear correlated with yield per stalk	Coefficient of correlation			
	1909	1910	1911	1912
Length of ear	0.300 ± 0.061	0.058 ± 0.067	0.118 ± 0.067	−0.027 ± 0.067
Average circumference of ear	0.148 ± 0.066	0.207 ± 0.065	0.138 ± 0.066	0.241 ± 0.064
Ratio of tip circumference to butt circumference	....	0.014 ± 0 067	0.045 ± 0.067	−0.052 ± 0.067
Average circumference of cob	....	....	....	0.246 ± 0.063
Weight of ear	0.323 ± 0 060	0.090 ± 0.067	0.151 ± 0.066	0.185 ± 0.065
Percentage of grain	−0.009 ± 0.067	−0.043 ± 0.067	−0.097 ± 0.067	0.237 ± 0.064
Average weight of kernels	....	0.043 ± 0.067	−0.063 ± 0.067	−0.023 ± 0.067
Weight of cob	0.158 ± 0.066	0.176 ± 0.065	0.139 ± 0.066	0.262 ± 0.063
Number of rows	−0.061 ± 0.069	−0 034 ± 0 067	0.119 ± 0.066	0.194 ± 0.065

the ear indicates in any way whatsoever whether or not the offspring produced will be a high-yielding type. The same relation holds with regard to the number of rows of kernels, the average weight of kernels, the ratio of tip circumference to butt circumference, and the percentage of grain. None of these seems to have any significant relation to the yield produced. On the other hand, the weight of the ear, the circumference of the ear and of the cob, and the weight of the cob, seem to show some slight relation to the yield. However, with three or four exceptions, these correlation coefficients are not significantly high, and it is doubtful whether any very great increase in yield would be obtained by selecting seed ears on this basis.

The correlations between seed-ear characters and yield per stalk for Cornell 12, for the years 1910 to 1914, inclusive, are shown in table 12. For comparison, the correlation coefficients obtained for the 1910 data from Webber's Early Dent are included. It will be remembered that in 1910 the corn from the seed ears of this variety was divided into two lots, one lot being planted in Saratoga County and the other being planted in Westchester County. It is interesting, then, to have the correlation studies under the two different environments for that year.

From these data it seems clear that the length of the seed ear is not indicative of a high yield, since none of the coefficients obtained are significant. The average circumference of ear and the average circumference of cob seem to show some slight relation to the yield per stalk. All of these correlation coefficients are positive, and, although not high, are rather consistent, thus indicating that there may be some slight correlation between the size of the ear as measured by the circumference, and the yield per stalk.

Of the other coefficients, none show any consistent relation except that of percentage of grain correlated with yield. These values, while not high, are all negative and very consistent, and may indicate that there is a slight negative correlation between high percentage of grain and yield per stalk. Some information regarding this may be obtained from table 13, the data in which show that in general the average yield per stalk of the ears with a high percentage of grain is lower than that of the ears with a low percentage of grain. The average yield per stalk for the high classes is 0.692 ± 0.023 and that for the low classes is 0.753 ± 0.029, the difference between the two being 0.061 ± 0.037. Thus, while the difference is consistent, yet when the difference between the averages is considered with its probable error it is not significant. Therefore, it cannot be concluded that there is any relationship between these characters.

TABLE 12. CORRELATIONS BETWEEN SEED-EAR CHARACTERS AND YIELD PER STALK FOR CORNELL 12, 1910 TO 1914

Characters of seed ear correlated with yield per stalk	Coefficient of correlation						
	1909*	1910*	1910†	1911	1912	1913	1914
Length of ear	0.300 ± 0.061	0.058 ± 0.067	0.068 ± 0.067	-0.013 ± 0.067	-0.102 ± 0.069	0.020 ± 0.067	0.165 ± 0.066
Average circumference of ear	0.148 ± 0.066	0.207 ± 0.065	0.129 ± 0.066	0.249 ± 0.063	0.360 ± 0.061	0.104 ± 0.067	0.134 ± 0.067
Ratio of tip circumference to butt circumference	....	0.014 ± 0.067	-0.115 ± 0.067	-0.087 ± 0.067	0.019 ± 0.070	0.085 ± 0.067	-0.131 ± 0.067
Average circumference of cob	....	....	0.189 ± 0.065	0.126 ± 0.066	0.274 ± 0.064	0.130 ± 0.066	0.185 ± 0.066
Weight of ear	0.323 ± 0.060	0.090 ± 0.067	0.029 ± 0.067	0.108 ± 0.067	0.249 ± 0.065	0.150 ± 0.066	0.099 ± 0.067
Percentage of grain	-0.009 ± 0.067	-0.043 ± 0.067	-0.163 ± 0.066	-0.173 ± 0.065	-0.051 ± 0.069	-0.046 ± 0.067	-0.183 ± 0.066
Average weight of kernels	....	0.043 ± 0.067	-0.118 ± 0.067	-0.114 ± 0.067	0.112 ± 0.069	-0.152 ± 0.066	0.082 ± 0.068
Weight of cob	0.158 ± 0.066	0.176 ± 0.065	0.136 ± 0.066	....	....	....	....
Number of rows	-0.061 ± 0.069	-0.034 ± 0.067	0.096 ± 0.067	0.097 ± 0.067	0.083 ± 0.069	-0.067 ± 0.067	0.032 ± 0.068
Average length of kernels	....	....	....	0.038 ± 0.067	....	....	-0.043 ± 0.068
Average width of kernels	....	....	....	0.162 ± 0.066	....	....	0.065 ± 0.068

* Saratoga County, Webber's Early Dent.
† Westchester County, Cornell 12.

It seems that when all of these correlation coefficients are considered, there is little evidence to indicate any relation between the seed-ear characters and the yield per stalk. Some further evidence may be obtained in some of the following tables.

TABLE 13. MEAN PERCENTAGES OF GRAIN IN THE SEED EARS IN A FEW OF THE HIGHEST AND THE LOWEST CLASSES, WITH THE MEAN YIELDS OF THESE CLASSES
(Cornell 12)

Year	High classes		Low classes	
	Percentage of grain	Yield per stalk (pounds)	Percentage of grain	Yield per stalk (pounds)
1910	87.074	0.822	81.676	0.859
1911	88.565	0.624	79.375	0.677
1912	87.158	0.672	80.750	0.738
1913	88.447	0.692	80.714	0.847
1914	87.235	0.651	82.750	0.645
Average	87.696	0.692±0.023	81.053	0.753±0.029

Difference in yield per stalk between high and low classes = 0.061 ± 0.037.

In addition to the correlation data just presented, the data were analyzed more closely in order to show the differences among ears that had come from

TABLE 14. YIELDS PER STALK OBTAINED FROM THE SHORTEST, LONGEST, LIGHTEST, AND HEAVIEST EARS FROM THE SAME PROGENY
(Cornell 11, 1909)

Progeny no.	Length and yield				Weight and yield			
	Short ears (centimeters)	Yield per stalk (pounds)	Long ears (centimeters)	Yield per stalk (pounds)	Light ears (grams)	Yield per stalk (pounds)	Heavy ears (grams)	Yield per stalk (pounds)
133-2	20.3	0.623	22.2	0.575	288	0.623	329	0.575
133-3	18.4	0.612	21.6	0.600	277	0.612	281	0.600
133-4	20.3	0.617	21.6	0.588	277	0.588	302	0.617
133-5	17.8	0.635	19.1	0.641	286	0.597	313	0.641
133-7	19.1	0.561	21.0	0.559	286	0.561	306	0.559
133-8	17.1	0.565	21.0	0.601	286	0.586	308	0.601
133-10	19.7	0.574	21.0	0.623	286	0.574	304	0.623
133-13	19.7	0.621	20.3	0.593	311	0.593	318	0.621
1-10-1	18.4	0.646	19.1	0.625	295	0.625	313	0.646
1-11-1	20.3	0.557	21.0	0.470	302	0.557	327	0.470
1-20-1	21.6	0.617	22.9	0.596	306	0.596	327	0.617
1-22-2	19.7	0.609	20.3	0.660	331	0.609	352	0.660
1-23-1	21.0	0.572	21.6	0.675	299	0.572	302	0.675
1-24-1	19 1	0.606	22.2	0.640	297	0.606	313	0.640
1-24-3	19.1	0.606	24.1	0.609	283	0.606	340	0.609
1-26-6	18.4	0.593	21.0	0.631	297	0.631	324	0.593
1-27-1	19.1	0.610	23.5	0.638	302	0.606	340	0.673
1-28-4	17.8	0.550	19.1	0.644	281	0.550	297	0.644
1-32-4	20.0	0.619	22.2	0.663	295	0 619	331	0.663
1-36-1	16.5	0.562	21.0	0.587	297	0.588	333	0.587
Average	19.2	0.598	21.3	0.611	294	0.595	318	0.616

the same mother ear and therefore had the same parentage on the female side. This was done by comparing the yields per stalk obtained from the longest ear from each progeny with those from the shortest, and also the yield from the heaviest ears with that from the lightest. Such data for the variety Cornell 11, for the years 1909 and 1910, are presented in tables 14 and 15. On inspection of these tables, it is apparent that the longest or the heaviest ears of a progeny do not always give a greater yield per stalk than do the shortest or the lightest ears. There are many instances in which the smallest ears yielded more per stalk than the largest ears. When the averages are determined there is really no significant difference shown, which is in accordance with the results as expressed by the correlation coefficients.

TABLE 15. YIELDS PER STALK OBTAINED FROM THE SHORTEST, LONGEST, LIGHTEST, AND HEAVIEST EARS FROM THE SAME PROGENY

(Cornell 11, 1910)

Progeny no.	Length and yield				Weight and yield			
	Short ears (centimeters)	Yield per stalk (pounds)	Long ears (centimeters)	Yield per stalk (pounds)	Light ears (grams)	Yield per stalk (pounds)	Heavy ears (grams)	Yield per stalk (pounds)
1-20-1-2......	18.1	0.619	20 2	0 571	218	0 571	226	0.616
1-20-1-1.......	18 3	0.583	20 2	0 537	227	0.583	238	0.523
1-22-1.........	17.3	0.641	19.3	0 530	190	0.641	207	0.475
1-23-1.........	20.8	0.521	21.7	0.643	227	0.643	231	0.521
1-32-1.........	16.7	0 557	17.3	0 523	185	0.557	226	0.469
1-26-4.........	17.9	0.515	19.6	0.629	197	0.515	227	0.504
1-27-1-1.......	18.1	0.648	19.5	0.555	216	0.596	256	0.508
1-27-1-2.......	17.1	0.535	23.0	0.630	217	0.535	279	0.630
1-27-1-3.......	19.2	0.594	21.2	0.546	196	0.594	254	0.546
1-27-1-4......	18.1	0.643	19.8	0 517	205	0.570	227	0.517
1-28-2.........	17.8	0.537	19 4	0 504	199	0.542	248	0.504
1-32-3.........	18.7	0.569	20.5	0 653	219	0.569	253	0.653
1-32-4-1.......	17.2	0.607	20.0	0.543	201	0.607	253	0.543
1-32-4-2.......	17.0	0.532	19.9	0 601	185	0 522	233	0.601
1-16-2.........	17.0	0.579	19.5	0.538	213	0.579	233	0.538
1-34-1.........	16.6	0 560	20.0	0 600	211	0.612	222	0.580
1-33-1........	17 5	0.512	19.5	0.464	218	0 464	243	0.581
1-35-1........	16.2	0.435	20.0	0 515	202	0.472	236	0.515
1-36-1.........	18.2	0.580	21.8	0 622	232	0.484	250	0.580
1-24-1.........	19.4	0.605	20.4	0 596	214	0.605	254	0.577
1-31-1........	18.7	0 572	19.2	0 573	228	0.573	250	0.572
1-46-1.........	16.7	0.446	20.4	0 598	202	0.446	289	0.621
1-22-2.........	17.5	0 568	18.0	0.537	224	0 568	228	0.643
Average......	17.8	0.563	20 0	0.566	210	0 558	242	0.557

Similar data for the years 1909, 1910, 1911, and 1912 are presented for Webber's Early Dent in tables 16, 17, 18, and 19. These tables present results similar to those for Cornell 11, and show that in some cases the shortest or the lightest ear of a progeny gives a greater yield per stalk than do the large ears. When all the results are taken together, as shown by the averages for the different years, it is found that the differences in yield per stalk from the different length and weight classes are very slight.

TABLE 16. YIELDS PER STALK OBTAINED FROM THE SHORTEST, LONGEST, LIGHTEST, AND HEAVIEST EARS FROM THE SAME PROGENY
(Webber's Early Dent, 1909)

Progeny no.	Length and yield				Weight and yield			
	Short ears (centimeters)	Yield per stalk (pounds)	Long ears (centimeters)	Yield per stalk (pounds)	Light ears (grams)	Yield per stalk (pounds)	Heavy ears (grams)	Yield per stalk (pounds)
3–15	21.0	0 593	24.1	0.734	304	0 595	352	0.734
3–27	19.7	0 571	22.2	0.536	284	0 555	318	0.536
3– 9	22.2	0.628	23.5	0.685	295	0.628	347	0.685
3–21	22 2	0.603	26 0	0.616	290	0.576	333	0.603
3–22	18.4	0.656	22.5	0 675	281	0 656	308	0.675
3–31	23.5	0.640	24.8	0.660	313	0.660	367	0.640
3–32	21.0	0.657	24.1	0 709	302	0.724	354	0 637
3–33	21.0	0.579	21.6	0.592	286	0.564	322	0.579
3–34	21.0	0.675	24.4	0.615	279	0.627	349	0.671
3–35	21.6	0.616	24.8	0.568	281	0.616	372	0.578
3–37	19.4	0.561	21.6	0.582	284	0.561	322	0 566
3–40	20.6	0.647	24.1	0.613	295	0 647	342	0.613
3–41	20.6	0.569	24.4	0.594	279	0 622	324	0.594
3–42	....	....	....	....	277	0.527	286	0.632
3–43	19.7	0.603	22.2	0.627	290	0.677	313	0.627
3–46	19.4	0.603	22.2	0.654	299	0.556	354	0.603
3–47	21 3	0.617	23.5	0 651	304	0.617	390	0.668
3–49	22.2	0.622	24.8	0.604	290	0.594	401	0.658
3–50	21.0	0.627	24.8	0.688	286	0.605	363	0 688
3–60	21.3	0.575	24.4	0.583	295	0.583	318	0.647
3–61	21.0	0.572	22.2	0.631	313	0 572	361	0 624
3–64	20.0	0.551	21.6	0.634	263	0.588	342	0.577
3–67	21.0	0.490	22.2	0.578	295	0.490	313	0.641
3–90	21.3	0.529	21.9	0.570	....	....	....	....
3–95	21.6	0.652	24 1	0.629	295	0.629	358	0.652
Average	20.9	0.601	23.4	0 626	291	0.603	342	0.630

TABLE 17. YIELDS PER STALK OBTAINED FROM THE SHORTEST, LONGEST, LIGHTEST, AND HEAVIEST EARS FROM THE SAME PROGENY
(Webber's Early Dent, 1910)

Progeny no.	Length and yield				Weight and yield			
	Short ears (centimeters)	Yield per stalk (pounds)	Long ears (centimeters)	Yield per stalk (pounds)	Light ears (grams)	Yield per stalk (pounds)	Heavy ears (grams)	Yield per stalk (pounds)
3–60–1	19.6	0.850	20.2	0.628	175	0.628	201	0.850
3–22–2	18.0	0.740	19.2	0.750	184	0.750	211	0.740
3–31–2	20.0	0.612	21.0	0.777	208	0.612	240	0.740
3–43–2	19.0	0.756	21.0	0.888	188	0.756	230	0.760
3–22–3	17.5	0.800	20.0	0.793	177	0.827	221	0 850
3–60–2	17.6	0.700	21.4	0.847	210	0 700	222	0.847
3–46–2	19.0	0.720	20.8	0.702	196	0 720	220	0.833
3–61–2	17.3	0.694	18.5	0.806	180	0.847	188	0.694
3–64–2	17.7	0.850	19.5	0.755	160	0.704	224	0.755
3–15–2	16.6	0.830	19.2	0.830	175	0.771	214	0 830
3–32–3	15.8	0.802	21.4	0.750	170	0 802	225	0.840
3–21–3	18.4	0.900	20.2	0.678	154	0.750	219	0.796
3–43–3	18.9	0.700	19.7	0.745	178	0.700	181	0.745
3–34–3	17.7	0.837	19.4	0.770	169	0.780	183	0.770
3–47–3	17.1	0.663	20.7	0.830	168	0 663	210	0.860
3–50–3	16.9	0.780	21.3	0.830	178	0.880	254	0.867
3–61–3	18.1	0.776	19.0	0.800	172	0.776	190	0.800
3–32–4	18.3	0.680	21.8	0.770	196	0.680	224	0.714
3–34–4	19.6	0.770	20.3	0.710	186	0.770	253	0.710
3–61–4	16.3	0.840	21.8	0.680	163	0.840	302	0.680
3–46–4	19.3	0.750	22.0	0.810	203	0.750	206	0.810
3–49–4	19.2	0.830	20.8	0.762	173	0.714	204	0.810
3–47–5	17.8	0.740	21.4	0.900	164	0 740	203	0.770
3–47–4	16.5	0.784	21.6	0.770	168	0.847	198	0 790
3–64–5	18 6	0.750	21.2	0.724	186	0.724	243	0.750
3–64–7	16.4	0.673	19.8	0.690	161	0 673	189	0.690
Average	18.0	0.763	20.5	0.769	179	0.746	218	0.781

TABLE 18. YIELDS PER STALK OBTAINED FROM THE SHORTEST, LONGEST, LIGHTEST, AND HEAVIEST EARS FROM THE SAME PROGENY

(Webber's Early Dent, 1911)

Progeny no.	Length and yield				Weight and yield			
	Short ears (centimeters)	Yield per stalk (pounds)	Long ears (centimeters)	Yield per stalk (pounds)	Light ears (grams)	Yield per stalk (pounds)	Heavy ears (grams)	Yield per stalk (pounds)
22-2-2	19.8	0.711	22.4	0.755	238	0.711	294	0.635
22-2-3	20.3	0.645	21.0	0.695	240	0.721	258	0.650
22-3-2	21.0	0.607	23.9	0.714	241	0.720	302	0.714
22-3-3	19.5	0.678	23.6	0.700	236	0.662	299	0.700
22-3-4	19.2	0.750	22.0	0.759	261	0.705	302	0.750
31-2-2	21.1	0.671	23.0	0.661	255	0.661	270	0.671
43-2-1	19.4	0.760	21.0	0.772	254	0.760	261	0.772
43-3-3	19.0	0.697	21.3	0.732	247	0.622	256	0.697
46-2-2	20.4	0.645	21.5	0.595	259	0.645	263	0.595
46-2-4	19.4	0.725	24.3	0.726	246	0.591	290	0.726
46-4-1	20.6	0.661	22.2	0.680	271	0.680	281	0.661
46-5-1	19.9	0.705	22.1	0.735	227	0.735	263	0.705
61-2-1	20.0	0.699	23.5	0.704	266	0.699	314	0.704
61-2-2	22.3	0.662	22.8	0.720	268	0.662	277	0.720
61-4-3	20.2	0.675	20.5	0.665	264	0.675	271	0.665
64-2-1	20.5	0.646	22.3	0.715	243	0.627	318	0.715
64-2-4	20.5	0.686	25.1	0.581	247	0.686	328	0.730
64-5-1	19.7	0.565	22.1	0.737	261	0.565	304	0.643
15-2-4	18.4	0.547	19.4	0.531	229	0.640	278	0.547
32-3-5	21.9	0.704	24.9	0.743	251	0.721	266	0.743
21-3-3	19.9	0.604	21.3	0.671	254	0.604	308	0.770
34-3-1	21.9	0.612	25.3	0.688	280	0.688	292	0.612
47-4-3	19.4	0.684	20.7	0.792	246	0.792	254	0.684
47-5-9	19.0	0.728	20.5	0.687	238	0.728	267	0.670
47-5-4	22.7	0.711	22.8	0.730	308	0.711	348	0.730
50-3-1	19.3	0.682	22.6	0.666	253	0.682	274	0.677
50-3-2	20.0	0.668	20.6	0.707	251	0.783	279	0.668
50-3-3	20.1	0.627	23.4	0.715	266	0.686	309	0.715
Average	20.2	0.670	22.4	0.699	254	0.684	287	0.688

TABLE 19. YIELDS PER STALK OBTAINED FROM THE SHORTEST, LONGEST, LIGHTEST, AND HEAVIEST EARS FROM THE SAME PROGENY

(Webber's Early Dent, 1912)

Progeny no.	Length and yield				Weight and yield			
	Short ears (centimeters)	Yield per stalk (pounds)	Long ears (centimeters)	Yield per stalk (pounds)	Light ears (grams)	Yield per stalk (pounds)	Heavy ears (grams)	Yield per stalk (pounds)
22-2-2-2	19.2	0.635	21.2	0.486	222	0.571	270	0.635
22-3-2-4	21.6	0.710	25.8	0.737	263	0.666	306	0.737
22-3-3-2	22.6	0.647	25.3	0.635	264	0.635	272	0.647
22-3-4-9	19.6	0.704	21.3	0.797	242	0.704	288	0.797
31-2-2-1	20.5	0.445	24.5	0.576	238	0.445	271	0.576
46-2-4-5	17.2	0.772	21.6	0.746	235	0.772	289	0.746
46-2-4-6	19.9	0.583	21.5	0.565	221	0.583	268	0.565
61-2-1-1	20.3	0.585	23.2	0.627	254	0.585	292	0.627
61-2-1-2	18.4	0.710	23.0	0.592	240	0.751	278	0.592
61-2-1-3	19.5	0.791	19.7	0.646	264	0.646	329	0.791
61-2-1-4	21.6	0.689	22.2	0.586	222	0.689	259	0.586
61-2-2-1	20.6	0.701	22.6	0.562	220	0.701	271	0.562
61-4-3-2	20.6	0.660	21.5	0.610	215	0.610	279	0.660
64-2-4-2	19.4	0.677	23.6	0.727	254	0.677	316	0.727
64-2-4-3	21.4	0.674	21.7	0.635	261	0.635	282	0.674
64-2-4-4	20.5	0.692	22.9	0.536	233	0.692	260	0.553
64-2-4-5	20.7	0.539	21.2	0.583	250	0.539	264	0.583
64-5-1-2	20.6	0.568	21.6	0.610	241	0.610	264	0.595
15-2-4-2	20.6	0.681	21.2	0.659	225	0.681	297	0.659
32-3-5-2	20.2	0.676	21.6	0.668	244	0.668	250	0.676
32-3-5-5	20.5	0.686	22.7	0.626	242	0.686	277	0.626
34-3-1-1	22.8	0.611	26.3	0.598	242	0.611	312	0.584
34-4-1-2	19.5	0.469	22.6	0.630	230	0.469	304	0.630
47-5-3-2	20.6	0.690	24.6	0.647	252	0.690	301	0.647

TABLE 19 (*concluded*)

Progeny no.	Length and yield				Weight and yield			
	Short ears (centimeters)	Yield per stalk (pounds)	Long ears (centimeters)	Yield per stalk (pounds)	Light ears (grams)	Yield per stalk (pounds)	Heavy ears (grams)	Yield per stalk (pounds)
47-5-3-7	19.8	0.573	25.7	0.672	234	0.597	264	0.672
47-5-4-2	21 4	0.747	24 9	0.615	260	0.615	281	0.765
50-3-1-3	20.1	0.679	22.5	0.519	225	0.679	274	0.519
50-3-2-1	20.4	0.763	23.2	0.589	228	0.713	287	0.731
50-3-2-6	21.0	0.717	23.5	0.730	236	0.717	274	0.686
50-3-3-1	19.9	0.544	24.4	0.760	223	0.544	265	0.652
Average	20 4	0.654	22.9	0.632	239	0.639	281	0.650

The average for the four years is shown in table 20. It is evident that, while the longer ears outyielded the shorter ears, the difference is very slight, and the average for the four years shows a difference of only 0.009 pound, although the seed ears differed in length by 2.4 centimeters. In regard to the yield from ears of different weight, the heaviest ears always gave the greatest yield per stalk. Here again the difference is small, particularly in the average, which is only 0.019 pound greater for the heavy ears.

TABLE 20. AVERAGE YIELDS PER STALK OBTAINED FROM THE SHORTEST, LONGEST, LIGHTEST, AND HEAVIEST EARS FROM THE SAME PROGENY

(Webber's Early Dent, 1909 to 1912)

Year	Length and yield				Weight and yield			
	Short ears (centimeters)	Yield per stalk (pounds)	Long ears (centimeters)	Yield per stalk (pounds)	Light ears (grams)	Yield per stalk (pounds)	Heavy ears (grams)	Yield per stalk (pounds)
1909	20.9	0.601	23.4	0.626	291	0.603	342	0.630
1910	18.0	0.763	20.5	0.769	179	0.746	218	0.781
1911	20.2	0.670	22.4	0.699	254	0.684	287	0.688
1912	20.4	0.654	22.9	0.632	239	0.639	281	0.650
Average	19.9	0.672	22.3	0.681	241	0.668	282	0.687

When all of the data here presented are considered, it seems that very little evidence is obtained that will enable one to select seed ears which will later, due to some visible character possessed, produce a high yield of grain. The characters of length, ratio of tip circumference to butt circumference, average circumference of cob, weight of cob, average weight of kernels, number of rows, and average length and width of kernels on the seed ears, do not show correlations significant enough to be of value in selecting seed corn for high yield. The data indicate a slight negative correlation between the percentage of grain in the seed ear and the yield, indicating that possibly ears containing a low percentage of grain yield

higher than do ears with a high percentage of grain. The average circumference of the seed ear is the only character that shows consistently any significant relation to yield. Hence the farmer, in selecting his seed corn, cannot pick the high-yielding seed ears when judging from outward characters of the ears. It is evident, therefore, that the points emphasized on a score card are of no value in seed-ear selection and are entirely for show purposes. The only basis left, then, for selecting high-yielding seed corn is the ear-to-row progeny test.

RELATION OF SEED-EAR CHARACTERS TO EARLY MATURITY

It is important to know whether any of the easily determined characters of a seed ear have any relation to its ability to produce early-maturing plants. With this in mind, the characters correlated with yield per stalk have been correlated also with early maturity. The method of determining the percentage of maturity has already been explained. The correlation coefficients for this study on Webber's Early Dent and Cornell 12 are given in table 21. On reviewing these data, it is apparent that, with the possible exceptions of the number of rows and the average weight of kernels, no other character gives correlation coefficients high enough to be of value in selecting early-maturing corn. Even these two exceptions are probably not sufficiently striking every year to be of practical value.

It would seem, then, that in general it is impossible, by any of the characters studied, to select ears that will give an early-maturing progeny. It may be possible, by selection, to secure early maturity and still maintain the size of ears and other desirable qualities. Since in this practice some growers might fear a reduction in the size of the corn thus selected, it seems desirable to present here the mean values for all of the characters studied. This is done for Webber's Early Dent, Cornell 11, and Cornell 12, and the data are given in tables 22, 23, and 24, respectively.

From the results here tabulated for Webber's Early Dent and for Cornell 12, it is easy to see that the means for length of ear, average circumference of ear, weight of ear, percentage of grain, average weight of kernels, number of rows, average length of kernels, and average width of kernels, have not decreased in the course of the experiment; that is, although the corn has become earlier through selection, the characters of the ear related to size have not, on the whole, decreased. In the case of Cornell 11 there is a slight indication that the weight of the ears and the number of rows may be decreasing, but the other characters are much the same as for the other strains. It is evident, therefore, that it is possible to select for early maturity and at the same time maintain practically the same size of ear or type of grain with which the experiment was begun.

TABLE 21. CORRELATIONS BETWEEN SEED-EAR CHARACTERS AND EARLY MATURITY FOR WEBBER'S EARLY DENT AND CORNELL 12

Characters of seed ear correlated with maturity	Coefficient of correlation					
	Webber's Early Dent				Cornell 12	
	1909	1910	1911	1912	1910	1911
Length of ear	-0.161 ± 0.066	0.092 ± 0.067	0.059 ± 0.067	0.212 ± 0.064	0.093 ± 0.067	-0.100 ± 0.067
Average circumference of ear	0.152 ± 0.066	-0.042 ± 0.067	-0.129 ± 0.066	-0.177 ± 0.065	0.034 ± 0.067	-0.059 ± 0.067
Ratio of tip circumference to butt circumference	....	0.096 ± 0.067	0.001 ± 0.067	-0.048 ± 0.067	0.002 ± 0.067	0.139 ± 0.066
Average circumference of cob	....	....	....	-0.089 ± 0.067	0.049 ± 0.067	0.083 ± 0.067
Weight of ear	0.046 ± 0.067	0.104 ± 0.067	0.012 ± 0.067	0.007 ± 0.067	0.288 ± 0.062	-0.027 ± 0.067
Percentage of grain	0.170 ± 0.066	-0.071 ± 0.067	0.249 ± 0.063	0.088 ± 0.067	0.009 ± 0.067	-0.030 ± 0.067
Average weight of kernels	....	0.196 ± 0.065	0.254 ± 0.063	0.306 ± 0.061	0.391 ± 0.057	-0.026 ± 0.067
Weight of cob	-0.151 ± 0.066	0.130 ± 0.066	-0.190 ± 0.065	-0.054 ± 0.067	0.207 ± 0.065	....
Number of rows	0.008 ± 0.070	-0.059 ± 0.067	-0.164 ± 0.066	-0.233 ± 0.064	0.260 ± 0.063	0.005 ± 0.067
Depth of kernels	0.152 ± 0.066	....	....	....	....	....

TABLE 22. MEANS OF CHARACTERS STUDIED IN SEED EARS OF WEBBER'S EARLY DENT FOR 1909 TO 1912

Characters	Means			
	1909	1910	1911	1912
Length of ear	22.040 ± 0.109	19.180 ± 0.097	21.300 ± 0.096	21.790 ± 0.117
Average circumference of ear	16.680 ± 0.056	14.520 ± 0.050	16.740 ± 0.058	15.020 ± 0.060
Ratio of tip circumference to butt circumference	....	0.885 ± 0.002	0.859 ± 0.002	0.847 ± 0.002
Average circumference of cob	....	....	....	9.290 ± 0.043
Weight of ear	311.600 ± 1.837	196.800 ± 1.698	271.600 ± 1.522	264.000 ± 1.795
Percentage of grain	85.730 ± 0.132	84.600 ± 0.158	84.570 ± 0.167	84.310 ± 0.141
Average weight of kernels	....	0.224 ± 0.002	0.275 ± 0.002	0.274 ± 0.002
Weight of cob	45.340 ± 0.349	31.680 ± 0.422	42.600 ± 0.494	41.790 ± 0.430
Number of rows	18.745 ± 0.138	16.980 ± 0.133	17.800 ± 0.138	16.840 ± 0.127
Depth of kernels	18.172 ± 0.078	....	....	....
Yield	0.612 ± 0.003	0.765 ± 0.004	0.680 ± 0.004	0.644 ± 0.005

TABLE 23. MEANS OF CHARACTERS STUDIED IN SEED EARS OF CORNELL 11 FOR 1909 TO 1913

Characters	Means				
	1909	1910	1911	1912	1913
Length of ear	20.513 ± 0.130	18.712 ± 0.086	20.351 ± 0.082	20.295 ± 0.095	20.122 ± 0.097
Average circumference of ear	....	15.066 ± 0.039	15.526 ± 0.057	15.839 ± 0.054	15.998 ± 0.051
Ratio of tip circumference to butt circumference	....	0.888 ± 0.002	0.850 ± 0.002	0.827 ± 0.003	0.879 ± 0.002
Average circumference of cob	....	9.581 ± 0.036	....	9.783 ± 0.049	10.079 ± 0.045
Weight of ear	308.701 ± 1.494	228.384 ± 1.372	277.190 ± 1.766	284.780 ± 2.265	263.170 ± 2.125
Percentage of grain	85.100 ± 0.212	82.535 ± 0.172	....	84.215 ± 0.159	83.184 ± 0.160
Average weight of kernels	....	269.646 ± 1.937	334.650 ± 3.005	303.391 ± 2.869	214.440 ± 2.353
Number of rows	19.000 ± 0.158	17.253 ± 0.118	17.560 ± 0.127	16.700 ± 0.130	16.910 ± 0.135
Average length of kernels	....	....	1.230 ± 0.005	....	1.205 ± 0.006
Average width of kernels	....	....	0.783 ± 0.004	....	0.838 ± 0.005
Yield	0.602 ± 0.004	0.553 ± 0.004	0.406 ± 0.005	0.650 ± 0.008	....

TABLE 24. MEANS OF CHARACTERS STUDIED IN SEED EARS OF CORNELL 12 FOR 1910 TO 1914

Characters	Means					
	1910	1911	1912	1913	1914	Average
Length of ear	19.310 ± 0.099	22.230 ± 0.099	20.830 ± 0.093	21.920 ± 0.115	22.622 ± 0.092	21.382 ± 0.045
Average circumference of ear	14.520 ± 0.050	15.420 ± 0.053	15.340 ± 0.067	15.640 ± 0.063	15.469 ± 0.057	15.278 ± 0.027
Ratio of tip circumference to butt circumference	0.891 ± 0.002	0.876 ± 0.002	0.854 ± 0.003	0.856 ± 0.002	0.817 ± 0.003	0.859 ± 0.001
Average circumference of cob	9.020 ± 0.043	9.260 ± 0.037	9.186 ± 0.045	9.255 ± 0.038	9.724 ± 0.042	9.289 ± 0.018
Weight of ear	198.400 ± 1.675	292.800 ± 1.879	273.400 ± 2.449	298.800 ± 2.446	301.840 ± 2.285	273.048 ± 0.070
Percentage of grain	84.100 ± 0.158	85.660 ± 0.176	84.947 ± 0.165	85.940 ± 0.167	85.612 ± 0.144	85.252 ± 0.073
Average weight of kernels	0.226 ± 0.002	0.295 ± 0.002	0.288 ± 0.003	0.311 ± 0.003	0.293 ± 0.003	0.283 ± 0.001
Weight of cob	31.680 ± 0.422	....	....	....	....	....
Number of rows	16.980 ± 0.133	17.220 ± 0.119	16.660 ± 0.147	16.820 ± 0.131	17.340 ± 0.152	17.004 ± 0.061
Average length of kernels	....	1.314 ± 0.005	....	....	1.314 ± 0.005	1.314 ± 0.003
Average width of kernels	....	0.772 ± 0.004	....	....	0.824 ± 0.004	0.798 ± 0.003
Yield	0.858 ± 0.005	0.669 ± 0.003	0.712 ± 0.005	0.764 ± 0.004	0.634 ± 0.003	0.727 ± 0.002

The average yield per stalk has decreased slightly, but when it is remembered that the corn has gradually become earlier each year, it is clear that at harvest time the corn would be drier and thus the average yield per stalk would become less. If data were available as to the actual amount of dry matter per stalk, then, without doubt, it would be found that this mean also did not decrease.

The conclusion derived from all these facts is that corn may be selected for yield or earliness without regard to the type of ear used for seed. Again, it seems that if such selection is carefully done, it is not necessary to change the type at all.

VALUE OF EARLY-MATURING DENT CORNS FOR GRAIN AND SILAGE

The methods and results of breeding work have been described in some detail in the foregoing pages, and the relations of type to maturity and to yield of grain have been discussed. It now remains to determine the value of these relations for use in the silo, and to this end a comprehensive series of tests was started in 1918.

Some preliminary work, done on the farm of the Honorable Seth Low, in Westchester County, in 1911, indicated that the variety Cornell 12 was equal to the later varieties in yield of dry fodder and of grain per acre. In comparison with other sorts commonly grown in that section, it gave a lower green weight per acre but showed a much higher proportional dry weight. A large percentage of this dry weight was in the form of grain. Since that section was more favorably located for maturing the longer-season sorts, it was felt desirable to conduct experimental tests in the dairy counties farther north. In many of these counties the silo is in very wide use as a part of the farm equipment. A farm census taken in 1917 showed that in twenty-nine counties 429,560 acres were harvested for silage, the average yield per acre being 6.73 tons.

In the early days of the silo, special emphasis was laid on the succulence of the material used. Succulence has undoubted value in promoting a flow of milk, but in stressing succulence many men have overlooked the value of ensilage in basic food constituents.

SILAGE OF HIGH IN COMPARISON WITH LOW GRAIN CONTENT

Corn silage containing a large amount of grain, as contrasted with that containing a smaller amount, is probably superior, though the problem has not yet been fully worked out. The difference, however, is not wholly one of amount; it is also a matter of greater digestibility. Such evidence as is available indicates the marked superiority of corn that has reached the hard dough, or glazed, stage by the time it is put into the silo. Dr. W. H.

Jordan, Director of the New York Agricultural Experiment Station at Geneva, recommends the use of only those varieties that mature in the section under consideration, for, until the glazing stage is reached, there is a continuous gain in highly digestible dry matter. This feature, as well as the added amount of grain, is of utmost importance.

PLAN AND SCOPE OF THE WORK

The experimental data were obtained in the years 1918, 1919, and 1920, and constitute a preliminary report on a series of tests designed to determine the actual yield of green material, dry stover, and dry grain, from the different types of corn in various localities. As originally outlined, the plan contemplated obtaining such information especially regarding the three varieties herein considered — Cornell 12, Webber's Early Dent, and Cornell 11 — when grown in competition with the other sorts commonly used for silage. In the second year, other early dents were added to the test for further comparison. The tests were distributed rather widely in order to obtain information applicable to grain-growing as well as to dairy sections. Except in a few cases, not more than one test was conducted in any one county. In some cases the cooperator was chosen by the local farm bureau agent, who assisted also in planting and harvesting the crop.

The plan outlined was followed as strictly as conditions permitted. The soil area of each plat was always fairly uniform in apparent fertility and slope. A planting of each sort was always repeated at least three times in each plat. Each planting consisted, usually, of one row, about twenty-five hills long. A definite order of planting was followed, and after a full row of each sort had been planted, the entire series was repeated three or more times. It is realized that the method used fails to take account of the effects of competition between the larger and the smaller types of corn. The rate of planting was somewhat lower than that in general use among silage growers. It is probable that, with the rate used, the advantage, if any, was in favor of the larger-growing sorts. The planting was in hills, and was spaced, usually, about 3 feet 6 inches by 3 feet apart. Five kernels were planted in each hill, and when the corn came up, the hills were thinned to three stalks each.

In addition to the sorts specifically mentioned, a considerable number of other sorts, either locally grown or sold, were added to the tests. This made possible a comparison of these with the standard sorts, and served to indicate the possible value of such local sorts as might possess merit. Altogether, about forty-two varieties were used. Since the tables show the names of all these, they need not be specifically referred to here.

EARLY DENTS USED IN THE TESTS

As already stated, the three sorts that have been developed by ear-to-row breeding work conducted by the Department of Plant Breeding at Cornell University, were used in all tests. Owing to the fact that Cornell 12 has been grown for some years in Westchester County, it is considerably later in maturity than the other two. Webber's Early Dent has been grown in Saratoga County, and Cornell 11 in Cayuga County, since 1908. The more rigorous selection work necessitated by these northerly locations has resulted in types of corn which are from ten days to two weeks earlier in maturity, so far as grain ripening is concerned.

Two other early dent varieties were used in most of the tests in 1919 and 1920. These are both grown for grain purposes in Onondaga County, and, in central New York, regularly mature grain suitable for husking. These sorts are known as Alvord's White Cap Dent, a variety having yellow kernels with a white cap, and Onondaga White Dent, which has white kernels save for a tendency to purpling toward the tips of some ears. This purpling is probably due to the effects of the sunlight during the later part of the maturing season. Bloody Butcher and Oil Dent were added to the tests in 1920.

THE LATER-MATURING SORTS USED

Three Long-Island-grown varieties were tested. These included the yellow semi-flint variety known as Luce's Favorite, a variety widely grown for silage purposes in some sections of New York. Its season of growth, prior to maturity, is considerably longer than that of any of the six early dents mentioned, and slightly longer than that of Cornell 12. It is a large-growing variety, ears freely, has wide, shallow kernels and a large cob, and shows a marked tendency to produce suckers.

Cooper is a white, eight-rowed dent, and, on Long Island, is of somewhat earlier maturity than Luce's Favorite. It eared well in all tests. The variety known as Al Smith is very similar to Cooper in all respects except that the sides of the kernel are purple, with the cap almost white. The cob in both these corns is much smaller than in Luce's Favorite and in most of the large-eared flints. The yield of shelled grain, however, is higher in proportion to the size of the ears and also in proportion to the total green weight per acre. Both these corns lack the profuse sucker habit which is characteristic of Luce's Favorite.

OTHER VARIETIES TESTED

A reference to the tables of results in the various tests shows the large number of sorts used and their variation in maturity and in yield per acre.

Increased green weight is, in general, a fairly accurate gauge of lack of maturity. On the other hand, a smaller yield of green weight is, in some varieties, very closely associated with earlier maturity and heavy yield of grain.

METHOD OF CONDUCTING TESTS

All tests were repeated at least three times in order to eliminate errors due to soil variation and to secure the accuracy made possible by the law of averages. All the planting was done under the direct supervision of a representative of the Department of Plant Breeding. The rate of planting was uniform in each individual test. Since the number of stalks per acre was considerably below the rate commonly employed by silage growers using the larger varieties, the rate was probably to the disadvantage of the smaller types. However, in the absence of definite experimental data concerning the optimum rate of planting, the uniform rate of three stalks per hill was at all times followed. In the fall, the harvesting of the silage plat was done when the work of silo-filling in the section where the test was made was well under way. It is hoped that on this account the data will have a value locally greater than if the almanac alone were considered. One-half of each row in the entire series of a given plat was cut and weighed separately. From the average weights of each of the four rows (representing the four series), the green weight was calculated in tons per acre. At the time of cutting, carefully selected samples of the material were hauled by truck to Cornell University for the purpose of determining the dry weights per acre. The dry ears on these samples were later removed and the yield of shelled corn was calculated on the acre basis. Always the total dry weights per acre, as given in the tables, include both grain and stover.

In 1919, the half of each plat which remained after the silage was harvested, was allowed to stand until later in the season, when the ears were husked and weighed. A sample of about 20 pounds of each sort was dried at the College, shelled, and weighed, and its yield per acre, in bushels of dry shelled grain, was calculated. These data appear in the final columns of the tables for 1919. In 1920 similar data were obtained on five plats and the record is given in table 54 (page 264.)

NUMBER AND LOCATION OF TESTS

Tests in 1918

Tests were conducted in six counties in 1918, but dry weights were obtained in only three of these. Consequently, the data for only these three are here given (tables 25 to 27).

TABLE 25. TESTS OF CORN VARIETIES IN CHENANGO COUNTY IN 1918*
(On the farm of L. M. Walworth at Norwich)

Variety	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Dry shelled grain per acre in silage (pounds)	Stage of maturity
Cornell 12	20.14	23.1	4.63	1,198	Late milk
Cornell 11	15.48	26.2	4.02	1,297	Soft dough to glazed
Webber's Early Dent	13.34	26.4	3.46	1,232	Soft dough to glazed
Luce's Favorite	22.01	19.0	4.18	972	Milk
Sweepstakes	21.28	17.4	3.62	485	Milk
West Branch	14.71	22.7	3.38	1,037	Late milk
Eureka	20 91	19.0	3.97	65	Blister

* Hills planted 3½ feet by 3 feet apart. Fifty-seven hills of each variety harvested. Planted May 21, harvested September 16

It will be observed that in Chenango County (table 25), the late-maturing corns were Luce's Favorite, Sweepstakes, and Eureka. The average green weight is 21.4 tons per acre, of which not more than 19 per cent is dry matter. The early-maturing Cornell 11 and Webber's Early Dent yield an average of 14.4 tons of green weight per acre, of which 26.3 per cent is dry matter. Cornell 12, which stands between the two groups, is highest of all in yield of dry weight, though fourth in respect to green weight per acre. It is superior to Luce's Favorite by 0.45 ton of dry matter and by 226 pounds of grain, though it contains 1.87 tons less of green matter per acre.

TABLE 26. TESTS OF CORN VARIETIES IN CAYUGA COUNTY IN 1918*
(On the farm of E. W. Mosher at Aurora)

Variety	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Dry shelled grain per acre in silage (pounds)	Stage of maturity
Cornell 12	9.86	24.0	2.37	1,164	Late milk
Cornell 11	7.14	34.1	2.43	2,371	Dough
Webber's Early Dent	6.88	31.6	2.20	1,880	Dough
Luce's Favorite	10.34	21.4	2.17	1,343	Milk
Western Union	7.99	22.6	1.84	1,028	Late milk
Wheeler's Angel of Midnight	5.70	34.3	1.94	1,655	Glazed

* Hills planted 28 inches by 39 inches apart. Eighty hills of each sort harvested and weighed. Planted June 1, harvested October 2.

Cornell 11 yielded 6.53 tons less of green matter per acre than did Luce's Favorite, yet it lacked only 0.16 ton of having as much dry matter and actually contained 325 pounds more per acre of shelled grain in the silage. Sweepstakes and Eureka, though giving heavy green weight per acre, were no greater than Cornell 11 in dry weight, and were markedly lower in yield of grain in silage per acre. Webber's Early Dent, though yielding 8.67 tons less of green material per acre than the heaviest of the late varieties, yet fell behind it by only 0.72 ton of dry weight, and in dry grain even excelled it, by 260 pounds.

In Cayuga County (table 26), the late-maturing sorts were Luce's Favorite and Western Union. Both of these gave lower actual yields of dry matter than the others, though higher green weight per acre than all but Cornell 12. The superiority of the early dents in grain per acre in the silage is also evident. Wheeler's Angel of Midnight showed inferiority in yield of dry weight, although it was third in weight of grain.

TABLE 27. Tests of Corn Varieties in Erie County in 1918*

(On the farm of Seth Brunck at Alden)

Variety	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Dry shelled grain per acre in silage (pounds)	Stage of maturity
Cornell 12	12.66	21.5	2.79	1,739	Milk
Cornell 11	8.40	30.5	2.60	2,647	Glazed
Webber's Early Dent	8.64	31.1	2.68	2,683	Dough
Luce's Favorite	14.01	18.2	2.52	1,891	Soft milk
Early White Cap Dent	10.72	32.3	3.43	2,042	Dough
Early Yellow Flint	6.87	26.9	1.85	1,700	Hard glazed
Brunck's Yellow Dent	7.82	30.5	2.42	2,229	Glazed

* Hills 3 feet by 3 feet apart. Sixty hills of each variety harvested. Planted May 28, harvested September 18.

In Erie County (table 27), the early dents, Cornell 11 and Webber's Early Dent, yielded much less green weight per acre than did Cornell 12 or Luce's Favorite. In dry weight per acre, their yield was slightly above that of Luce's Favorite and a little lower than that of Cornell 12. They are, however, markedly superior to both these sorts in yield of grain in the silage.

The summary (table 28) shows that the two early dents tested yield an average of 5.47 tons less of green weight per acre than does Luce's Favorite, but only 0.06 ton less of dry weight and 617 pounds per acre more of grain.

TABLE 28. SUMMARY OF CORN VARIETY TESTS IN CHENANGO, CAYUGA, AND ERIE COUNTIES IN 1918

Variety	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Dry grain per acre (pounds)
Cornell 12	14.22	22.9	3.26	1,376
Cornell 11	10.34	29.2	3.02	2,105
Webber's Early Dent	9.62	29.0	2.79	1,932
Luce's Favorite	15.45	19.1	2.96	1,402
Wheeler's Angel of Midnight*	6.28	30.0	1.89	1,677

* Average of two tests only.

Tests in 1919

The tests in Erie and Cayuga Counties were continued in 1919, and to these were added one each in Jefferson, Tioga, Delaware, and Ontario Counties. The results of these trials are given in tables 29 to 41, inclusive. In each table except the summary tables, the final column gives the yield in bushels per acre of shelled dry grain obtained from husking that half of the plat which was not harvested for silage. The general data, including the dates of planting, harvesting of silage, and husking of grain, and the stage of maturity, are given in footnotes to the tables. Great care was exercised to obtain accurate dry weights. Owing to the distance of the Delaware County plats from the College, the dry-weight determinations were made by Professor C. H. Wall, of the New York State School of Agriculture at Delhi. Besides planting and harvesting the green-silage weights, Professor Wall obtained practically all the data given in table 36. It may be further remarked that data concerning the yield of grain not in silage were obtained after allowing the material to stand for several weeks after the harvest of the silage part.

The results of the tests in Ontario and Cayuga Counties may be considered together, as their degree of maturity was greater than that of the tests to be mentioned later. The growth season was favorable and all varieties reached either the hard dough or the glazed stage. For convenience in analyzing the material, the average performance of the four early dents — Onondaga White Dent, Alvord's White Cap, Cornell 11, and Webber's Early Dent — may be compared. The two varieties Cooper and Al Smith may also be considered together, in comparison with Luce's Favorite, Cornell 12, and other late sorts. The yield of each individual variety may be compared with that of every other variety, but the summary of the performance of the early dents, as compared to that of the later sorts, is of special interest.

The amount of green weight needed to produce a ton of dry matter is given in the final column of each of the summary tables.

In Ontario County the yields were as given in table 29. The summary of these results, wherein the four early dents are compared with Cornell 12, Luce's Favorite, the two late-season corns of Long Island, and two flints, is given in table 30. For Cayuga County the results are given in table 31 and summarized in table 32.

TABLE 29. TEST OF CORN FOR GRAIN AND SILAGE IN ONTARIO COUNTY, 1919*
(On the farm of G. B. VanGelder at Canandaigua)

Variety	Silage					Grain		
	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Percentage of green weight as dry shelled grain	Dry shelled grain per acre (pounds)	Husked ears per acre (pounds)	Dry grain shelled (per cent)	Shelled grain per acre (bushels)
Cooper	8.33	36.7	3.06	16.7	2,782	5,365	47.1	45.1
Cornell 12	7.75	38.2	2.96	16 4	2,536	5,386	43.5	41.8
Webber's Early Dent	6.06	47.7	2.89	24.8	3,007	5,025	56.3	50.5
Al Smith	8.33	34.8	2.90	14.7	2,442	4,863	42.7	37.1
Onondaga White Dent	6.13	45.1	2.76	24.3	2,978	5,431	56.0	54.3
Leaming	7.59	37.1	2.81	15.7	2,388	6,117	43.9	48.0
Alvord's White Cap	4.94	54.6	2.70	24.5	2,424	4,696	60.9	51.0
Cornell 11	4.73	47.9	2.26	23.1	2,182	4,761	54 5	46.3
Luce's Favorite	8.47	29.6	2.51	12.5	2,117	5,585	36.2	36.1
McLane White Cap	5.84	38.4	2.24	16.9	1,972	5,154	46.1	42.2
Morse's Flint	4 90	43.8	2.14	20.1	1,968	3,862	54.2	37.4
Sheffield Flint	3 70	54.4	2.01	30.0	2,220	2,551	62.6	28.5

*Planted May 8, 1919. Silage harvested September 24. Grain corn husked October 4. Hills 3 feet 6 inches by 3 feet apart. Rows 24 hills long, replicated four times. For silage, 8 hills per row harvested. For grain, 48 hills harvested except for the following: Cornell 12, Alvord's White Cap, Luce's Favorite, 47 each; McLane White Cap, 46.

Stage of maturity on September 24: Hard glazed — Webber's Early Dent, Onondaga White Dent, Alvord's White Cap, Cornell 11, McLane White Cap, Morse's Flint, Sheffield Flint. Hard dough — Cooper, Cornell 12, Al Smith, Leaming, Luce's Favorite.

These tests show the practical possibilities of the various sorts where seasonal conditions were exceptionally favorable in bringing all to the condition of maturity recommended for silage. The Ontario County

TABLE 30. SUMMARY OF DATA IN TABLE 29 (ONTARIO COUNTY)

Variety	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Weight of grain in silage (pounds)	Tons of green weight needed to produce one ton of dry matter
Cornell 12	7.75	38.2	2.96	2,536	2.62
Average of Cooper and Al Smith	8.33	35.7	2.98	2,612	2.80
Luce's Favorite	8.47	29.6	2.51	2,117	3.37
Average of the two flints	4.30	49.1	2.08	2,094	2.07
Average of the four early dents	5.46	48.8	2.63	2,648	2.08

TABLE 31. TEST OF CORN FOR GRAIN AND SILAGE IN CAYUGA COUNTY, 1919*
(On the farm of E. W. Mosher at Aurora)

Variety	Silage					Grain		
	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Percentage of green weight as dry shelled grain	Dry shelled grain per acre (pounds)	Husked ears per acre (pounds)	Dry grain shelled (per cent)	Shelled grain per acre (bushels)
Cornell 12	14.27	29.0	4.14	11.8	3,376	7,813	50.1	69.9
Cornell 11	10.00	35 4	3.54	18.6	3,712	6,099	54.2	59.0
Webber's Early Dent	10.80	33.9	3.66	14.2	3,069	6,109	54.7	59 6
Luce's Favorite	18.38	23.8	4.37	8.6	3,147	9,130	40 6	66.2
Onondaga White Dent	11.66	33.4	3.89	16.2	3,768	7,507	53 1	71.1
Cooper	17.45	27.2	4.74	11.3	3,930	8,790	45.8	71 9
Al Smith	16.68	28.7	4.78	11.5	3,850	8,766	47.1	73.8
Alvord's White Cap	10.17	36 3	3.69	17.3	3,525	6,118	55.9	61.0
Hall's Golden Nugget	15.32	27.9	4.28	12.9	3,965	8,043	48.9	70.3

* Planted May 26, 1919. Silage harvested September 16. Grain corn husked October 3. Hills 3 feet 6 inches by 3 feet 3 inches apart. Rows 20 hills long, replicated five times in order listed in table For silage, 8 hills per row cut and weighed. For grain, 10 hills per row husked and weighed.

Stage of maturity on September 16: Well glazed — Cornell 11, Webber's Early Dent, Alvord's White Cap, Onondaga White Dent, Hall's Golden Nugget. Hard dough — Cornell 12, Cooper, Al Smith, Luce's Favorite.

TABLE 32. SUMMARY OF DATA IN TABLE 31 (CAYUGA COUNTY)

Variety	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Weight of grain in silage (pounds)	Tons of green weight needed to produce one ton of dry matter
Cornell 12	14.27	29.0	4.14	3,376	3.45
Average of Cooper and Al Smith	17.06	27.9	4.76	3,890	3.58
Luce's Favorite	18.38	23.8	4.37	3,147	4.20
Hall's Golden Nugget	15.32	27.9	4.28	3,965	3.58
Average of the four early dents	10.66	34.7	3.69	3,518	2 89

test was on soil of only medium fertility, while that in Cayuga County was on highly fertile soil. In the former locality the four early dents averaged higher in dry weight than did the flints or Luce's Favorite. The last column in the summary tables shows the number of tons of green weight required to produce one ton of dry matter. Whether it is profitable to handle the much larger green weight per ton of dry matter ensiled, except on very high-priced land, is open to question. Comparing Luce's Favorite with the average of the four dents in the Cayuga County test, the results show that 1.31 tons more of moisture per ton of dry matter are handled in Luce's Favorite than in the average of the dents, while the actual amount of grain per acre is less. It is doubtful whether, with the high labor costs of placing corn in the silo and taking it out again, this large amount of extra water can be considered a profitable investment. Added to this is the fact that the average amount of grain in silage from the early dents

is usually greater than that from the later-maturing sorts, though in the Cayuga County test, where the seasonal conditions were especially favorable for the later sorts, the difference is not so marked.

In Erie County the test was on light soil and the season was somewhat dry. The corn made good growth and the yields compare favorably with what may be expected in the average season in that part of the State. The complete data are given in table 33 and summarized in table 34.

TABLE 33. TEST OF CORN FOR GRAIN AND SILAGE IN ERIE COUNTY, 1919*
(On the farm of Seth Brunck at Alden)

Variety	Silage					Grain		
	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Percentage of green weight as dry shelled grain	Dry shelled grain per acre (pounds)	Husked ears per acre (pounds)	Dry grain shelled (per cent)	Shelled grain per acre (bushels)
Cornell 12	8.57	23.6	2.02	6.1	1,051	3,986	48.3	34.4
Cornell 11	6.83	29.7	2.03	13.5	1,849	4,431	52.3	41.4
Webber's Early Dent	6.70	26.4	1.77	11.1	1,485	4,057	52.6	38.1
Luce's Favorite	10.45	20.8	2.17	5.7	1,200	3,844	42.2	29.0
Onondaga White Dent	6.68	27.9	1.86	10.4	1,391	3,523	53.3	33.5
Cooper	8.63	24.4	2.10	6.2	1,079	2,705	43.2	20.9
Al Smith	8.86	20.6	1.83	6.5	1,159	3,061	42.7	23.3
Alvord's White Cap	6.56	32.1	2.10	14.4	1,889	3,915	56.3	39.4
Hall's Golden Nugget	8.95	23.9	2.14	9.7	1,734	4,449	48.3	38.3

* Planted May 30, 1919. Silage harvested September 11. Grain corn husked September 25. Hills 3 feet by 3 feet apart. Rows 30 hills long (except block 4, 38 hills), replicated four times. For silage, 15 hills per row cut and weighed. Balance husked and weighed for grain.

Stage of maturity on September 11: Early glazed — Cornell 11, Alvord's White Cap, Onondaga White Dent. Dough — Webber's Dent, Hall's Golden Nugget, Al Smith. Milk — Cornell 12, Luce's Favorite, Cooper.

TABLE 34. SUMMARY OF DATA IN TABLE 33 (ERIE COUNTY)

Variety	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Weight of grain in silage (pounds)	Tons of green weight needed to produce one ton of dry matter
Cornell 12	8.57	23.6	2.02	1,051	4.24
Luce's Favorite	10.45	20.8	2.17	1,200	4.81
Average of Cooper and Al Smith	8.75	22.5	1.96	1,119	4.46
Hall's Golden Nugget	8.95	23.9	2.14	1,734	4.17
Average of the four early dents	6.69	29.0	1.94	1,653	3.44

In this test the four early dents yielded an average of 3.76 tons less of green weight per acre than did Luce's Favorite, and 2.07 tons less than the average of Cornell 12, Cooper, Al Smith, and Hall's Golden Nugget. The corresponding differences in dry weight are 0.23 ton and 0.10 ton. In yield of grain in silage, the dents are markedly superior to all the other sorts except Hall's Golden Nugget.

The tests in Tioga, Delaware, and Jefferson Counties may be considered together, and are given in tables 35 to 37, inclusive.

TABLE 35. TEST OF CORN FOR GRAIN AND SILAGE IN TIOGA COUNTY, 1919*
(On the farm of John Dermody at Richford)

Variety	Silage					Grain		
	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Percentage of green weight as dry shelled grain	Dry shelled grain per acre (pounds)	Husked ears per acre (pounds)	Dry grain shelled (per cent)	Shelled grain per acre (bushels)
Cornell 12	21.96	17.7	3.90	3.9	1,704	10,018	30.7	55.0
Cornell 11	15.35	21.4	3.29	7.4	2,266	7,351	39.7	52.2
Webber's Early Dent	16.56	20.7	3.43	6.5	2,163	7,720	38.4	52.9
Luce's Favorite	22.63	15.8	3.57	4.1	1,837	8,633	27.7	42.7
Onondaga White Dent	18.24	19.4	3.53	6.9	2,506	7,062	41.0	51.8
Cooper	21.54	17.3	3.74	4.5	1,926	8,814	28.9	45.4
Al Smith	23.72	17.1	4.07	4.3	2,030	8,207	28.2	41.4
Alvord's White Cap	17.14	21.2	3.64	7.3	2,506	5,987	41.3	44.1
Sweepstakes	24.95	15.0	3.73	2.6	1,302	9,567	19.3	32.9

*Planted May 31, 1919. Silage harvested September 6 Grain corn husked September 29. Hills 3 feet by 3 feet apart Rows 12 hills long, replicated four times. For silage, 5 hills per row cut and weighed. For grain, 6 hills per row husked and weighed.

Stage of maturity on September 6: Late milk — Cornell 11, Webber's Early Dent, Alvord's White Cap, Onondaga White Dent. Milk — Cornell 12, Luce's Favorite, Cooper, Al Smith. Early milk — Sweepstakes.

TABLE 36. TEST OF CORN FOR GRAIN AND SILAGE IN DELAWARE COUNTY, 1919*
(At the State School of Agriculture, Delhi)

Variety	Silage					Grain		
	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Percentage of green weight as dry shelled grain	Dry shelled grain per acre (pounds)	Husked ears per acre (pounds)	Dry grain shelled (per cent)	Shelled grain per acre (bushels)
Cornell 12	23.37	19.5	4.56	5.1	2,384	11,310	31.4	63.5
Cornell 11	16.66	21.3	3.54	8.8	2,939	7,975	41.0	58.4
Webber's Early Dent	16.29	21.8	3.55	9.0	2,939	7,676	40.8	55.9
Luce's Favorite	29.30	16.3	4.77	4.5	2,660	10,493	27.9	52.3
Onondaga White Dent	18.48	21.0	3.89	8.2	3,045	8,751	42.8	66.8
Cooper	27.65	18.1	5.01	6.0	3,340	9,786	29.5	51.6
Al Smith	28.26	17.0	4.79	5.6	3,193	8,901	29.7	47.2
Alvord's White Cap	15.79	22.3	3.53	10.2	3,227	6,737	44.5	53.5
Steuben County Flint	12.99	23.3	3.03	9.4	2,452	5,240	47.3	44.2
Dibble's Mammoth Yellow Flint	33.56	16.0	5.36	3.9	2,631	10,670	25.2	48.0
Dibble's Early Yellow Dent	22.50	17.7	3.99	3.5	1,570	9,309	28.0	46.6
Mastodon	27.97	15.6	4.37	1.5	845	9,710	15.1	26.2
Dutchess County Flint	26.52	16.3	4.31	3.2	1,692	9,329	26.2	43.7
Early Wonder Dent	21.70	19.1	4.14	5.3	2,317	9,692	31.8	55.1
North Dakota White Flint	22.63	18.0	4.08	5.1	2,322	7,351	40.5	53.1
Duke's White Cap Yellow Dent	17.22	20.7	3.57	5.0	1,708	7,050	40.6	51.1
Wisconsin 7	20.70	19.3	4.00	6.4	2,650	9,772	38.2	66.7

* Planted May 27, 1919. Silage harvested September 19 Grain corn husked October 25. Hills 3 feet 2 inches by 3 feet 2 inches apart Rows 20 hills long, replicated four and five times For silage, 8 hills per row cut and weighed. For grain, 10 hills per row husked.

Stage of maturity on September 19: Glazed — Steuben County Flint. Ears denting, early dough — Webber's Early Dent. Well eared, early dough — Cornell 11, Onondaga White Dent, Alvord's White Cap. Well eared, milk — Early Wonder Dent. Well eared, soft milk — Duke's White Cap Yellow Dent, Wisconsin 7. Late milk — Cornell 12, Dibble's Early Yellow Dent. Milk — Cooper, Al Smith. Early milk — Luce's Favorite. Soft milk — Dutchess County Flint, North Dakota White Flint. Blister — Dibble's Mammoth Yellow Flint, Mastodon.

TABLE 37. TEST OF CORN FOR GRAIN AND SILAGE IN JEFFERSON COUNTY, 1919*
(On the farm of Clayton Langworthy at Adams Center)

Variety	Silage					Grain		
	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Percentage of green weight as dry shelled grain	Dry shelled grain per acre (pounds)	Husked ears per acre (pounds)	Dry grain shelled (per cent)	Shelled grain per acre (bushels)
Cornell 12	21.86	20.1	4.40	4.9	2,125	8,216	36.6	53.7
Cornell 11	19.02	25.5	4.84	9.4	3,587	10,805	39.5	76.1
Webber's Early Dent...	15.77	22.9	3.62	7.6	2,413	8,664	40.9	63.3
Luce's Favorite	21.10	16.7	3.53	3.3	1,384	9,632	34.5	59.4
Cooper	22.01	20.2	4.44	5.4	2,368	9,123	34.2	55.6
Alvord's White Cap	15.20	26.3	3.99	10.4	3,177	8,228	47.3	69.5
Hall's Golden Nugget	16.94	19.2	3.25	5.4	1,823	7,345	40.5	53.2
Bloody Butcher....	18.07	25.2	4.56	10.2	3,686	10,176	44.9	81.5
Golden Glow	19.51	21.0	4.10	6.5	2,544	9,765	44.2	77.0
Lake Erie Dent....	19.78	19.9	3.94	3.6	1,444	9,039	35.8	57.8
Bailey Dent..	18.49	21.1	3.90	6.2	2,301	10,430	30.8	57.4
Harris White Cap..	18.60	20.1	3.73	5.9	2,191	8,422	40.8	61.4
Leaming	18.75	20.5	3.84	4.3	1,627	9,486	34.2	57.9
Local Luce's Favorite	19.47	17.9	3.48	3.8	1,347	8,881	26.5	42.1
Wheeler's Angel of Midnight	13.91	22.1	3.08	10.1	2,824	7,296	48.1	62.7

* Planted June 4, 1919. Silage harvested September 10. Grain corn husked October 8. Hills 3 feet by 3 feet apart. Rows 24 hills long, replicated four times. For silage, 8 hills per row cut and weighed. For grain, 16 hills per row husked and weighed.

Stage of maturity on September 10: Glazed — Wheeler's Angel of Midnight. Milk to late milk — all other varieties.

In these tests the early dents reached a late milk to dough stage, but the later sorts were never beyond the soft milk stage at the time of harvesting the silage. Unfortunately, Al Smith and Onondaga White Dent were not included in the Jefferson County test, and these are therefore omitted from the summary. Their performance in the Tioga and Delaware County tests may be observed in tables 35 and 36.

A summary of these three tests is given in table 38:

TABLE 38. SUMMARY OF DATA IN TABLES 35, 36, AND 37 (TIOGA, DELAWARE, AND JEFFERSON COUNTIES)

Variety	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Weight of grain in silage (pounds)	Tons of green weight needed to produce one ton of dry matter
Cornell 12	22.39	19.1	4.29	2,071	5.21
Luce's Favorite	24.34	16.3	3.96	1,960	6.14
Average of the three early dents	16.42	22.6	3.71	2,802	4.42
Cooper	23.73	18.5	4.39	2,545	5.40

Considering the cost of ensiling corn as $2 a ton, to place an average acre of Luce's Favorite in the silo would cost $48.68. The corresponding figure for the three early dents would be $32.84. The dents give within a quarter

ton as much dry matter as Luce's Favorite, and 842 pounds more grain. On the average, in these tests, Cornell 12 and Cooper give about 0.6 and 0.7 ton more of dry matter, respectively, than the early dents, but they are somewhat lower in yield of grain.

The Jefferson County test, when taken by itself, shows the results summarized in table 39. In this table are shown the average performances of the three early dents and of three slightly later dents, in comparison

TABLE 39. SUMMARY OF DATA IN TABLE 37 (JEFFERSON COUNTY)

Variety	Green weight per acre (tons)	Dry matter (per cent)	Dry weight per acre (tons)	Weight of grain in silage (pounds)	Tons of green weight needed to produce one ton of dry matter
Cornell 12	21.86	20.1	4.40	2,125	4.97
Luce's Favorite	21.10	16.7	3.53	1,384	5.97
Average of the three early dents*	16.66	24.9	4.15	3,059	4.01
Average of the three medium-season dents†	18.69	22.4	4.19	2,844	4.47

*Cornell 11, Webber's Early Dent, Alvord's White Cap.
† Bloody Butcher, Golden Glow, Bailey Dent.

with those of Luce's Favorite and Cornell 12. Aside from the greater digestibility of these dents due to their greater maturity, their relatively high total dry weights and their high yield of grain per acre indicate their probable superiority in actual food nutrients when put in the silo. To this is added the lower labor cost involved, as evidenced by the smaller amount of green weight handled per ton of dry weight.

In table 40 is given the summary of the silage and grain corn tests in all six counties in 1919, for each sort appearing in two or more of the counties. A summary of the data in table 40 is given in table 41. From this table it is clear that the early dents are the most economical to grow when silo space and the cost of putting material into the silo is considered. This is especially true wherever the late-maturing sorts fail to reach the dough or the glazed stage. The season of 1919 was unusually favorable for corn growth and maturity. It is hardly to be expected, however, that in the average season the late varieties would have as good an opportunity as during that season. For this reason it would seem that the early dents are likely to prove more economical in cost of handling, being productive of as much or more highly nutritious dry matter per acre, and also, because of their greater digestibility due to maturity, being more valuable for milk and beef production.

TABLE 40. SUMMARY OF THE SILAGE AND GRAIN CORN TESTS IN SIX COUNTIES IN 1919*

Variety	Green weight per acre (tons)	Dry weight per acre (tons)	Dry shelled grain per acre in silage (pounds)	Husked corn shelled per acre (bushels)
Cornell 12	16.30	3.66	2,196	53.0
Cornell 11	12.10	3.25	2,756	55.6
Webber's Early Dent	12.03	3.15	2,513	53.4
Luce's Favorite	18.39	3.49	2,057	47.6
Onondaga White Dent	12.24	3.19	2,738	55.5
Cooper	17.60	3.85	2,571	48.4
Al Smith	17.17	3.67	2,535	44.6
Alvord's White Cap	11.63	3.27	2,791	53.1
Hall's Golden Nugget	13.74	3.22	2,507	53.9
Leaming	13.17	3.32	2,007	52.9

* All sorts were tested in six counties except as follows: Al Smith and Onondaga White Dent, five counties; Hall's Golden Nugget, three counties; Leaming, two counties.

TABLE 41. SUMMARY OF DATA IN TABLE 40

Variety	Green weight per acre (tons)	Dry weight per acre (tons)	Dry shelled grain per acre in silage (pounds)	Tons of green weight needed to produce one ton of dry matter
Cornell 12	16.30	3.66	2,196	4.45
Luce's Favorite	18.39	3.49	2,057	5.27
Average of the four early dents*	12.00	3.21	2,699	3.74
Average of the two Long Island dents†	17.38	3.76	2,553	4.62

* Cornell 11, Webber's Early Dent, Alvord's White Cap, Onondaga White Dent.
† Cooper, Al Smith.

Tests in 1920

In 1920 the work was continued in Delaware, Tioga, Jefferson, Cayuga, Tompkins, Erie, and Ontario Counties. Tests were conducted also on the grounds of the State Schools of Agriculture at Cobleskill in Schoharie County and Morrisville in Madison County.

The season of 1920 was very favorable to the production and maturity of the silage corn crop. Most of the plats were harvested between September 15 and 30. At that time most of the early dents were glazed, even at the higher elevations. The later varieties were usually in the soft milk stage. The work of obtaining dry weights of material for the plat at Delhi was done by Professor C. H. Wall, of the New York State

School of Agriculture. For Schoharie County a similar service was performed by Professor E. D. Day, of the Agronomy Department of the New York State School of Agriculture at Cobleskill.

TABLE 42. CORN VARIETY TEST, ONTARIO COUNTY, 1920
(On the farm of W. C. Buell at Holcomb)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Onondaga White Dent	8.09	35.36	2.86	18.2	2,944.76
Morse's Flint	9 02	31.37	2.83	15.3	2,760.12
Oil Dent	7 33	37 20	2.73	19.2	2,814.72
U. S. 193	10.94	25.00	2.73	9.7	2,122.36
Cornell 11	8.51	31 88	2.71	15.4	2,621.08
Pride of the North	9.07	28 89	2.62	11.1	2,013.54
Cornell 12	9 83	26.09	2.56	12.3	2,418.18
Bloody Butcher	6.73	37.08	2.50	18.9	2,543.94
Alvord's White Cap	6.56	35.82	2.35	18.1	2,374.72
Wheeler's Angel of Midnight	5.41	43.02	2.33	20.3	2,196.46
Al Smith	9.11	24.83	2.26	9.7	1,767.34
Webber's Early Dent	7.24	30.88	2.24	14.7	2,128.56
Luce's Favorite	8.80	25.00	2.20	9.2	1,619 20
Sheffield Flint	5.57	38.39	2 14	19.4	2,161.16

TABLE 43. CORN VARIETY TEST, ONTARIO COUNTY, 1920
(On the sanatorium farm at Clifton Springs)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Luce's Favorite	24.31	23.12	5 62	7.0	3,403.40
U. S. 193	18.72	22.35	4.18	9.4	3,519.36
Cornell 11	14.11	29.29	4.13	14.9	4,204.78
Cornell 12	15.86	26.06	4.13	11.5	3,647.80
Pride of the North	17.14	23.90	4.10	10.8	3,702 24
Onondaga White Dent	13.67	29 73	4.06	14.7	4,018.98
Oil Dent	12.93	29.86	3.86	15.1	3,904.86
Morse's Flint	15.28	24.82	3 79	11.6	3,544.96
Al Smith	17.61	21.32	3.75	8.1	2,852.82
Webber's Early Dent	13.29	27.54	3.66	13.5	3,588.30
Bloody Butcher	11.17	30 08	3.36	16.3	3,641.42
Alvord's White Cap	11.53	27.36	3.15	13.8	3,182.28
Wheeler's Angel of Midnight	11.42	23.86	2 72	10.5	2,398.20
Sheffield Flint	9.94	26 61	2.65	12.7	2,524.76

TABLE 44. CORN VARIETY TEST, ONTARIO COUNTY, 1920
(On the farm of Charles Buchan at Stanley)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
U. S. 193	20 33	21.65	4.40	8.5	3,456.10
Cornell 12	17 45	24.84	4 33	10.3	3,594.70
Luce's Favorite	18 48	22.27	4 12	8.2	3,030.72
Onondaga White Dent	12.67	30 93	3.92	16.1	4,079.74
Cornell 11	12.91	29 17	3.77	13.3	3,434.06
Alvord's White Cap	11 27	32.95	3.71	14 8	3,335.92
Dibble's White Cap (Buchan's seed*)	14 30	25.35	3.63	11.1	3,174.60
Al Smith	16 05	21 77	3.49	7.5	2,407.50
Oil Dent	9.31	32.85	3 06	16.9	3,146.78
Wheeler's Angel of Midnight	9.35	31.98	2.99	14.2	2,655.40
Webber's Early Dent	10.11	28 15	2.85	13.5	2,729.70

* Mr Buchan bought this for White Cap but it looked like Learning.

TABLE 45. CORN VARIETY TEST, JEFFERSON COUNTY, 1920
(On the farm of Clayton R. Langworthy at Adams Center)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Wheeler's Angel of Midnight	11.49	26.02	2 99	10.2	2,343.96
Onondaga White Dent	14.22	21.64	3 08	9.8	2,787.12
Webber's Early Dent	11.91	25.52	3.04	9.7	2,310.54
Alvord's White Cap	12.67	24.69	3 13	9.2	2,331.28
Oil Dent	12.93	26 28	3 40	9.1	2,353 26
Bloody Butcher	12 29	27 50	3 38	11.9	2,925.02
Cornell 11	12.74	......	......	....	....
Pride of the North	14 86	23.68	3.52	7.5	2,229.00
Gold Dollar White Cap Dent (local)	19.93	19 19	3 82	4.7	1,873.42
Rising Pride White Cap Dent (local)	16.86	23.50	3.96	7 9	2,663.88
Early King Yellow Dent (local)	.....	19.62	....	4.3	....
West Branch Sweepstakes	19 78	20.68	4.09	6.4	2,531.84
U. S. 193	17.58	20.97	3 69	7.3	2,566.68
Hall's Golden Nugget	17 05	20 79	3.54	8.3	2,830.30
Luce's Favorite	20.38	18 29	3.73	5.4	2,201.04
Al Smith	15 83	21.49	3 40	6.7	2,121.22
Cooper	17.43	21.59	3.76	6 9	2,405.34
Average of five early dents	12.80	......	3.20	....	2,541.00
Average of five later corns	18.88	......	3.87	....	2,335.00

TABLE 46. CORN VARIETY TEST, JEFFERSON COUNTY, 1920
(On the farm of George Greenley at Adams)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Onondaga White Dent	14.97	17.66	2.64	3.1	928.14
West Branch Sweepstakes	15.99	19.16	3.06	1.1	351.78
Bloody Butcher	12.93	18.96	2.45	2.9	749.94
Alvord's White Cap	12.89	16.49	2.13	3.1	799.18
Webber's Early Dent	12.25	19.26	2.36	2.5	612.50
Cornell 11	12.10	18.23	2.21	2.6	629.20
Wheeler's Angel of Midnight	12.36	17.21	2.13	4.7	1,161.84
Hall's Golden Nugget	14.22	15.83	2.25	1.7	483.48
Oil Dent	10.55	21.17	2.23	2.3	485.30
Pride of the North	14.41	17.90	2.58	1.4	403.48
Luce's Favorite	21.36	13.40	2.86	0.8	341.76
U. S. 193	14.52	16.00	2.32	1.3	377.52
Rising Pride White Cap Dent	14.07	20.09	2.83	0.8	225.12
Golden Glow	11.68	16.29	1.90	1.9	443.80
Al Smith	16.26	17.71	2.88	0.6	195.12
Cornell 12	13.76	14.87	2.05	1.1	302.72
Cooper	16.41	17.47	2.87	0.6	196.92
Improved Leaming	13.20	16.73	2.21	0.7	184.80
Gold Dollar White Cap	14.67	16.85	2.47	0.6	176.04
Early King Yellow Dent	13.61	15.59	2.12	0.6	163.32

TABLE 47. CORN VARIETY TEST, MADISON COUNTY, 1920
(At the State School of Agriculture, Morrisville)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Onondaga White Dent	20.53	24.06	4.94	11.2	4,598.72
Cornell 11	19.96	23.37	4.66	10.5	4,191.60
Oil Dent	17.05	26.46	4.51	11.4	3,887.40
Tucker's Dent (early yellow)	20.23	22.43	4.54	9.4	3,803.24
Alvord's White Cap	17.89	24.35	4.36	10.5	3,756.90
Bloody Butcher	17.24	25.32	4.37	10.4	3,585.92
Webber's Early Dent	17.43	24.21	4.22	10.3	3,590.58
Luce's Favorite	25.64	19.18	4.92	6.9	3,538.32
U. S. 193	23.48	20.75	4.87	7.5	3,522.00
Pride of the North	21.70	21.73	4.72	7.9	3,428.60
Cooper	25.67	20.62	5.29	6.8	3,491.12
Al Smith	22.69	20.23	4.59	6.7	3,040.46
Wheeler's Angel of Midnight	14.86	25.18	3.74	12.1	3,596.12

TABLE 48. CORN VARIETY TEST, CAYUGA COUNTY, 1920
(On the farm of R. E. Mosher at Aurora)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Onondaga White Dent	15.72	25.26	3.97	11.2	3,521.28
Bloody Butcher	13.92	27.53	3.83	12.8	3,563.52
Brill's Cornell 12	18.07	23.16	4.19	8.1	2,927.34
Pride of the North	15.82	24.88	3.94	9 9	3,132.36
Alvord's White Cap Dent	14.63	26.49	3 88	10.9	3,189.34
Cornell 11	15.14	25.45	3 85	10.1	3,058.28
Webber's Early Dent	12.79	25.87	3.31	10.2	2,609.16
Oil Dent	13.43	26.65	3.58	11.2	3,008.32
U. S. 193	20.52	19.29	3.96	6.9	2,831.76
Luce's Favorite	21.01	18.75	3.94	6.1	2,563 22
Cornell 12	16.33	22.62	3.69	8.5	2,776.10
Cooper	19.62	19 70	3.87	5.8	2,275.92
Wheeler's Angel of Midnight	13 24	23.67	3.13	9.8	2,595.04
Al Smith	17.03	20.24	3.45	6.0	2,043.60

TABLE 49. CORN VARIETY TEST, SCHOHARIE COUNTY, 1920
(At the State School of Agriculture, Cobleskill)

Variety*	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Onondaga White Dent	15 22	25 73	3.92	10.8	3,287.52
Alvord's White Cap	13.61	25.30	3.44	10.2	2,776.44
Cornell 11	14.23	23 27	3.31	9.5	2,703.70
Bloody Butcher	12.39	25.39	3.15	10.5	2,601.90
Webber's Early Dent	12.79	24.60	3.15	9.8	2,506.84
Oil Dent	12.74	25.12	3.20	8.4	2,140.32
Wheeler's Angel of Midnight	11.07	27.19	3.01	10.9	2,413.26
Pride of the North	15.51	21.94	3 40	7.4	2,295.48
Cooper	19.91	18.08	3.60	4.8	1,911.36
Luce's Favorite	18.14	18.28	3.32	4.1	1,487.48
U. S. 193	16.44	18.43	3.03	5.5	1,808.40
Hall's Golden Nugget	12.83	21.61	2.77	8.2	2,104.12
Al Smith	15.90	19.56	3.11	5.1	1,621.80
Cornell 12	9.77	19.88	1.94	6.0	1,172.40

* The stand was three stalks to a hill except for Cornell 12, which had one stalk to a hill.

The silage data for three tests in Ontario County, two in Jefferson county, and one each in Madison, Cayuga, Schoharie, Tioga, Delaware, and Tompkins Counties, are given in tables 42 to 52, inclusive, and are summarized in table 53. The summary table (table 53) does not include all of the local sorts used, but gives the performances of one early flint, six early

dents, and three later sorts. Attention is called to the last column of the table, showing the amount of green weight handled per ton of dry matter obtained.

TABLE 50. CORN VARIETY TEST, TIOGA COUNTY, 1920
(On the farm of Daniel Dean at Nichols)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Cooper	17.54	25 72	4 51	8.8	3,087.04
Al Smith	16.68	25 15	4 20	8.5	2,835.60
White Cap Dent	15.65	26 28	4.11	9.1	2,848.30
Onondaga White Dent	11 57	32.86	3 80	11.7	2,707 38
Alvord's White Cap	9.91	33 80	3 35	13.9	2,754.98
Early Wonder	14 90	24.04	3 58	8.2	2,443 60
Pride of the North	14.33	24 61	3.53	8.0	2,292.80
West Branch Sweepstakes	17 32	22 02	3.81	5.4	1,870.56
Luce's Favorite	15.81	21 25	3 36	6.7	2,118.54
Cornell 11	11.61	27.46	3.19	9 1	2,113.02
U. S. 193	14.22	22.60	3 21	7.1	2,019.24
Oil Dent	9.79	28 80	2.82	11.1	2,173.38
Bloody Butcher	9.15	28.72	2.63	9.0	1,647.00
Webber's Early Dent	8.56	28.94	2.48	10.2	1,746.24
Wheeler's Angel of Midnight	5.90	36.07	2 13	17.5	2,065.00
Cornell 12	13.46	22.64	3.05	5.4	1,453 68

TABLE 51. CORN VARIETY TEST, DELAWARE COUNTY, 1920
(At the State School of Agriculture, Delhi)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Wheeler's Angel of Midnight	18.69	20.23	3.78	8.56	3,200
Dutchess County Flint	21.38	17 93	3.83	4.29	1,840
Onondaga White Dent	19.71	21.13	4.16	7.50	2,960
Webber's Early Dent	18.29	21.80	3.99	7.81	2,860
Alvord's White Cap	20.46	22.20	4 54	8.83	3,620
Oil Dent	15.60	21.76	3 39	7.56	2,360
Bloody Butcher	18.86	22.86	4.31	8.78	3,320
Early Wonder	23.15	18.65	4.32	5.19	2,400
Cornell 11	20.37	20.21	4.12	7.26	2,960
Pride of the North	22.66	18.79	4.26	5.24	2,380
U. S. 193	23.78	17 19	4.09	3.91	1,860
U. S. 119	29.18	15.25	4.45	0 00	0
Cornell 12	17.52	17.17	3.01	3.58	1,260
Luce's Favorite	26.36	15.62	4.12	2.94	1,540
Al Smith	24 18	16.21	3.92	3.09	1,500
Cooper	23.93	17 26	4.13	3.84	1,840
Dibble's Mammoth Yellow Flint	22 22	17 68	3.93	4.27	1,900
Lancaster Sure Crop	27 78	15.87	4.41	1.95	1,080

TABLE 52. CORN VARIETY TEST, TOMPKINS COUNTY, 1920
(At Ithaca)

Variety	Green weight per acre (tons)	Total dry matter (per cent)	Total dry matter (tons)	Percentage of dry grain in green weight	Dry shelled grain per acre in silage (pounds)
Onondaga White Dent	11.99	34 37	4 12	13.9	3,333.22
West Branch Sweepstakes	16.46	26.05	4.29	9.4	3,094 48
Leaming	16.49	25 88	4.27	9.0	2,968.20
Luce's Favorite	17.66	21.79	3 85	7.1	2,507.72
Pride of the North	14.19	25.27	3.59	9.0	2,554.20
Cornell 11	10 72	29.03	3 11	11.3	2,422.72
Brill's Cornell 12	14 07	23 09	3.25	8.2	2,307.48
Alvord's White Cap	9 03	32.53	2 94	13.4	2,420.04
U. S. 193	15.19	19 78	3.00	7.1	2,156.98
Cooper	14.24	21.09	3.00	6.9	1,965 12
Bloody Butcher	9.66	27 67	2.67	11.6	2,241.12
Oil Dent	8.69	28.76	2.50	12 1	2,102.98
Webber's Early Dent	8.86	28.66	2.54	10.5	1,860.60
Wheeler's Angel of Midnight	5.51	21 39	1.18	10 0	1,102.00
Guard Rows	14.96	24 48	3.66	7.7	2,303.84
Cornell 12	......	22.67	...	8.4	....
Al Smith	...	23 65	.....	8.6	....

TABLE 53. SUMMARY OF SILAGE CORN VARIETY TESTS IN 1920

Variety	Number of tests	Green weight per acre (tons)	Dry weight per acre (tons)	Dry shelled grain per acre in silage (pounds)	Green weight per ton of dry matter (tons)
Wheeler's Angel of Midnight	11	10 85	2.74	2,339	3.96
Webber's Early Dent	11	12.14	3.08	2,413	3.94
Bloody Butcher	10	12 43	3.26	2,682	3.81
Oil Dent	11	11.85	3 21	2,580	3.69
Alvord's White Cap	11	12.77	3.36	2,776	3.80
Cornell 11	10	13 97	3.51	2,834	3.98
Onondaga White Dent	11	14.40	3.77	3,197	3.82
Pride of the North	10	15.97	3.63	2,443	4.40
Luce's Favorite	11	19.81	3 82	2,214	5.19
Cooper	8	19.34	3 88	2,147	4.98

In tables 54 to 58, inclusive, are given the results of tests in Erie, Ontario, Cayuga, and Tompkins Counties, in which the yield of dry shelled grain at husking time was determined. The corn on these plats was allowed to stand until about November 1, when it was husked and samples were dried, shelled, and weighed. The yield is calculated as dry shelled grain in bushels (56 pounds) per acre.

TABLE 54. GRAIN CORN TEST, ERIE COUNTY, 1920
(On the farm of Seth Brunck at Alden)

Variety	Green weight per acre (pounds)	Green weight as dry shelled grain (per cent)	Dry shelled grain per acre (bushels)
Cornell 11	7,363.41	52.9	69.6
Bloody Butcher	6,775.72	56.9	68.8
Onondaga White Dent	6,827.57	54.6	66.6
Pride of the North	7,985.67	49.4	70.4
Alvord's White Cap	6,239.88	57.2	63.7
Webber's Early Dent	6,343.59	55.0	62.3
Oil Dent	6,257.17	54.7	61.1
Wheeler's Angel of Midnight	5,099.07	57.3	52.2
Luce's Favorite	8,141.23	43.6	63.4
U. S. 193	7,709.11	44.5	61.3
Al Smith	6,585.58	49.0	57.6
Cornell 12*	4,839.80	52.4	45.3

* The stand was very poor.

TABLE 55. GRAIN CORN TEST, ONTARIO COUNTY, 1920
(On the sanatorium farm at Clifton Springs)

Variety	Weight of husked ears per acre (pounds)	Dry shelled grain (per cent)	Dry grain per acre (bushels)
Pride of the North	8,852.64	60.6	95.8
U. S. 193	9,775.80	54.3	94.8
Onondaga White Dent	8,055.81	63.4	91.2
Luce's Favorite	9,532.87	50.6	86.1
Webber's Early Dent	7,443.60	63.0	83.7
Cornell 11	7,317.28	63.5	83.0
Oil Dent	7,521.34	58.9	79.1
Al Smith	8,007.22	54.5	77.9
Alvord's White Cap	6,209.48	67.4	74.7
Morse's Flint	6,889.71	60.5	74.4
Bloody Butcher	6,452.42	61.3	70.6
Wheeler's Angel of Midnight	5,684.74	64.2	65.2
Sheffield Flint	5,111.40	62.7	57.2

All of the varieties were apparently well matured when harvested. Luce's Favorite and U. S. 193 appeared to outyield the early dents, due to their large ears. When dried and shelled, however, the dents shrank on the average 41.3 per cent, whereas Luce's Favorite and U. S. 193 showed a shrinkage of 52.8 per cent. It is interesting to note that not only did the early dents outyield Wheeler's Angel of Midnight, but their

shrinkage was not appreciably greater. This flint variety is an early, high-yielding sort, yet its yield ranged between 12.7 and 24 bushels below that of the early dents. The heavy shrinkage of U. S. 193 and Luce's Favorite due to cob and moisture, as well as the difficulty of drying the grain in storage, makes these varieties undesirable for grain purposes. On the other hand, the lower moisture and cob content of the early dents indicates their higher maturity and keeping quality without sacrifice of yield of grain.

TABLE 56. GRAIN CORN TEST, ONTARIO COUNTY, 1920
(On the farm of Charles Buchan at Stanley)

Variety	Weight of husked ears per acre (pounds)	Dry shelled grain (per cent)	Dry grain per acre (bushels)
Cornell 11	7,441.50	60.1	79.9
Onondaga White Dent	6,927.25	64.1	79.3
Webber's Early Dent	6,461.40	63.4	73.2
Cornell 12	7,033.12	57.6	72.3
Alvord's White Cap	5,324.00	65.6	62.4
Luce's Favorite	7,163.20	45.8	58.6
Oil Dent	5,414.75	58.7	56.8
Al Smith	5,880.60	47.7	50.1
U. S. 193	5,808.00	46.3	48.0
Wheeler's Angel of Midnight	4,065.60	62.2	45.2

TABLE 57. GRAIN CORN TEST, CAYUGA COUNTY, 1920
(On the farm of R. E. Mosher at Aurora)

Variety	Weight of husked ears per acre (pounds)	Dry shelled grain (per cent)	Dry grain per acre (bushels)
Onondaga White Dent	8,054.53	64.1	92.2
Luce's Favorite	9,504.35	54.5	91.8
Pride of the North	8,237.10	60.2	88.5
Oil Dent	7,399.43	66.7	88.1
Cornell 11	8,097.49	60.8	87.9
Brill's Cornell 12	8,376.71	57.8	86.5
U. S. 193	8,763.33	55.2	86.4
Alvord's White Cap	7,442.39	64.8	86.1
Cooper	8,849.24	52.1	82.3
Al Smith	8,301.54	55.2	81.8
Bloody Butcher	7,259.82	62.5	81.0
Webber's Early Dent	6,465.10	65.6	75.7
Wheeler's Angel of Midnight	6,357.71	61.5	69.8
Cornell 12	....	62.0	....

TABLE 58 GRAIN CORN TEST, TOMPKINS COUNTY, 1920
(At Ithaca)

Variety	Weight of husked ears per acre (pounds)	Dry shelled grain (per cent)	Dry grain per acre (bushels)
Onondaga White Dent	6,647.44	49.2	58.4
Alvord's White Cap	5,641 62	55.2	55.6
Leaming	7,865.00	37.0	52.0
Bloody Butcher	6,004 62	47.5	50.9
U. S. 193	7,214.62	39.2	50.5
West Branch Sweepstakes	7,728.87	36.0	49.7
Cornell 11	6,065 12	44.7	48.4
Pride of the North	6,110.50	43.5	47.5
Luce's Favorite	6,889 44	38.0	46 7
Oil Dent	5,414 75	47.5	45.9
Brill's Cornell 12	6,511.31	38 5	44.8
Cooper	5,687 00	41.2	41.8
Webber's Early Dent	4,817.31	47.7	41.0
Wheeler's Angel of Midnight	3,630.00	54.0	35.0
Guard Rows	4,166.94	43.0	32.0

In table 59 is a summary of the data for these tests.

TABLE 59. SUMMARY OF GRAIN CORN TESTS IN 1920

Variety	Number of tests	Percentage of cob and moisture in husked ears	Dry shelled grain per acre (bushels)
Onondaga White Dent	5	41.0	77.5
Cornell 11	5	43.6	73.8
Alvord's White Cap	5	38.0	68.5
Oil Dent	5	42.7	66.2
Webber's Early Dent	5	41.1	67.2
Wheeler's Angel of Midnight	5	40.2	53.5
Luce's Favorite	5	53.5	69.3
U. S. 193	5	52.1	68.2

DISCUSSION OF RESULTS

The foregoing data were obtained from experimental plat tests of corn, and extend over the years 1918 to 1920. The object of the investigations was to obtain information in regard to the value of early-, medium-, and late-maturing varieties of corn for silage and grain purposes. Each test consisted of three or more replications of each sort tested. Green weights were obtained from all the replicated plats. Dry-weight data were obtained in the main from samples brought by truck to Ithaca, where they were artificially dried. In a few cases, however, these data were obtained by

local cooperators. Altogether, forty-two sorts, including thirty dents and twelve flints, were tested.

In 1918, which was a short-growth season, the early dents yielded approximately the same amount of dry matter per acre as did the later sorts. A large proportion of this dry matter was grain. The later sorts yielded from 3 to 7 tons per acre more of green weight, but were distinctly later in maturity and yielded less grain.

In 1919 and 1920, similar results were obtained. These seasons were more favorable to the later-maturing sorts than 1918 had been. The average yield of the four early dents in 1919 was 12 tons of green weight and 3.21 tons of dry weight per acre. In 1920 these same sorts gave 13.3 tons of green weight and 3.43 tons of dry weight. The corresponding green and dry weights for the four later varieties in 1919 was 17.36 and 3.64 tons, respectively; in 1920 the figures are 18.37 and 3.77 tons, respectively.

These data indicate that early dents may be expected to yield about 5 tons less of green weight and about 0.4 ton less of dry weight per acre than do the later-maturing sorts. Nevertheless, in short growing seasons, the early dents may yield as much dry matter as the late sorts, or more. While yielding less green and dry weight, the earlier dents reach better maturity, store much more of their dry matter in the form of grain, and are probably more digestible, than the more immature late sorts.

The labor and storage cost per ton of dry matter is less for the early dents than for the late sorts. This applies to both the labor involved in putting in, and that in removing, the ensiled material.

Because of their greater degree of maturity, the early dents are more digestible, as well as more palatable, when fed to beef cattle or dairy cows than are those sorts that do not reach the glazed stage at harvest time.

The experiments indicate that the early dents, though slightly lower in yield of dry matter, are to be preferred for silage purposes because of their greater digestibility, higher yield of grain, and greater economy of handling.

SUMMARY

Individual ear-to-row breeding plats were conducted in three different regions of New York. Three strains of corn — Cornell 11, Cornell 12, and Webber's Early Dent — were isolated. The first two are early dents, and the third is somewhat later.

In making selections for yield and for maturity, a selection coefficient was found to be of considerable value.

Mass selection is practiced in order to maintain the strains produced by individual selection.

From the data presented, it does not seem practicable to attempt to select for high yield or earliness by choosing ears that exhibit certain charac-

ters. It is evident that selecting good, sound ears from progenies that are early and high-yielding, is more satisfactory than selecting merely show ears or ears that possess certain characteristics such as a certain length, weight, or number of rows.

In New York, the early-maturing dent varieties are the most profitable types of corn for silage purposes. The results from three years of experimental work show that these varieties give a larger yield of highly digestible nutrients per acre than do the later-maturing dents or flints.

ACKNOWLEDGMENT

The authors desire to express their thanks to the various cooperators who furnished land and assistance in carrying out the experimental work described in this paper, and also to the county agricultural agents in the counties in which the work was done.

April, 1922 Bulletin 409

An Economic Study of Dairying on 149 Farms in Broome County, New York

E. G. Misner

Published by the
Cornell University
Agricultural Experiment Station
Ithaca, New York

CONTENTS

AN ECONOMIC STUDY OF DAIRYING ON 149 FARMS IN BROOME COUNTY, NEW YORK

E. G. Misner

The rapid growth of the milk trade, increases in the cost of milk production, and advances in the price of milk to consumers, have made the economic problems concerned in the production, transportation, and distribution of market milk of increasing public concern. This bulletin is

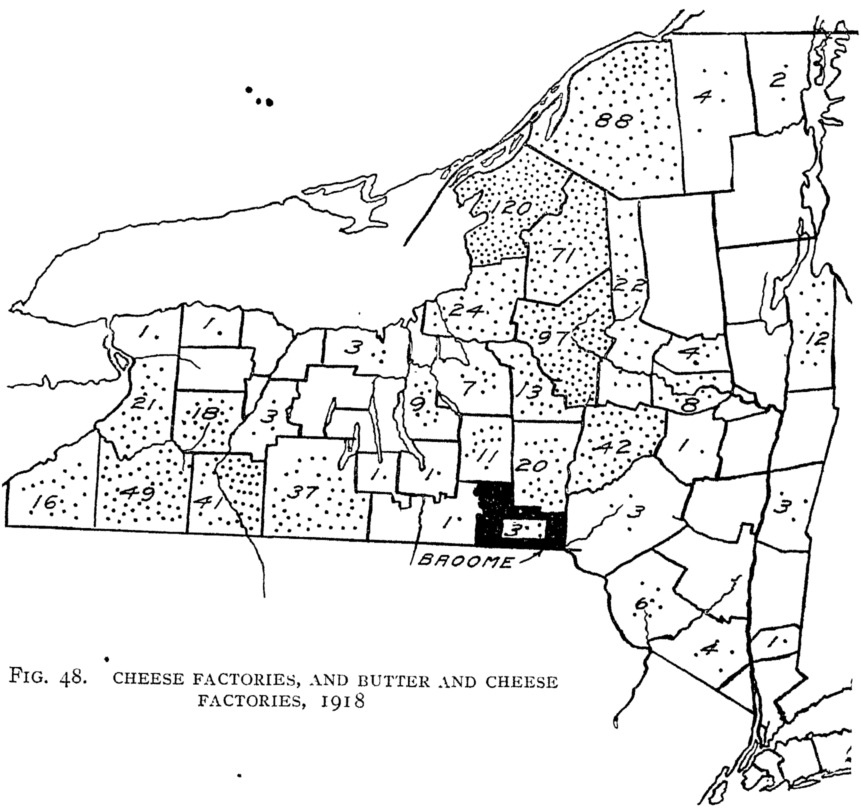

FIG. 48. CHEESE FACTORIES, AND BUTTER AND CHEESE FACTORIES, 1918

a report of a cost study, concerned only with the problems of production, not with those of transportation or distribution. The costs in terms of dollars are out of date because prices have changed, but the quantities are not affected so much by price changes.

AUTHOR'S ACKNOWLEDGMENTS. The dairymen of Broome County, New York, furnished the production data for this study. The investigation was under the direction of Professor G. F. Warren, of the Department of Agricultural Economics and Farm Management, New York State College of Agriculture. Professor E. S. Savage, of the Department of Animal Husbandry, advised for that part of the study relating to feeding. Professor K. C. Livermore gave criticisms and helpful suggestions. E. R. Minns assisted the writer in doing the field work. To these and to all others who helped with the work, the writer is indebted.

During July and August, 1915, in cooperation with the Broome County Farm Improvement Association, data concerning the dairy business for the year ending May 1, 1915, were obtained from 149 farmers in Broome County.

The exact figures for the pounds of milk delivered to the milk stations and the amount paid were obtained for each farm from the companies buying the milk. Some farmers kept no record of milk sold, and thus

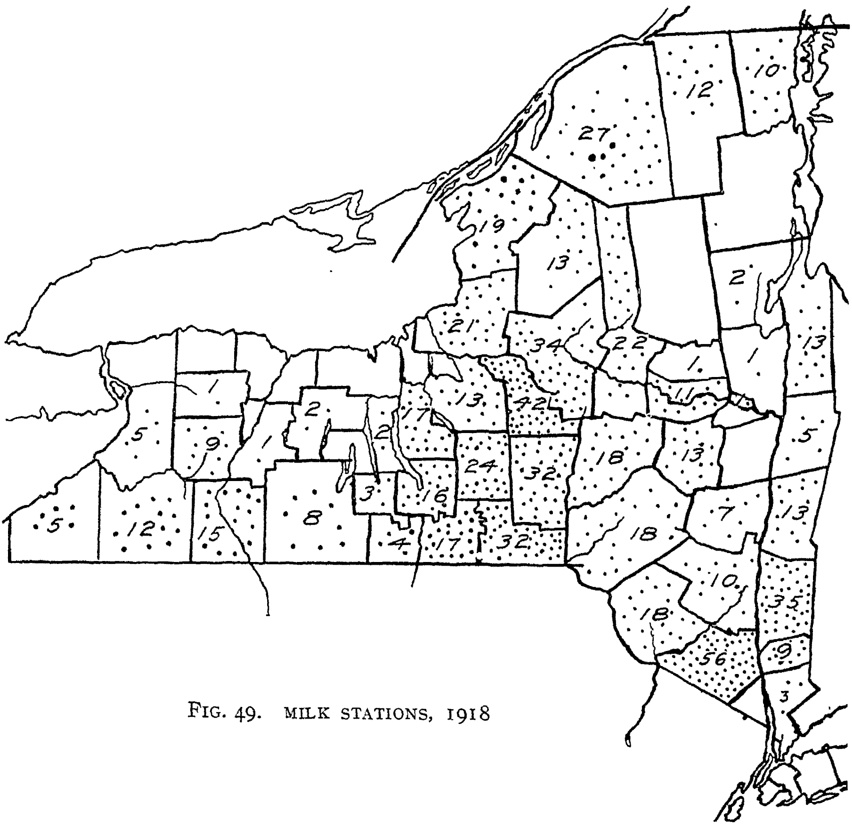

FIG. 49. MILK STATIONS, 1918

the necessity of accepting estimates as to the sales of milk was eliminated. For 114 farms, the average butterfat test of the milk by months was given by the companies. Other information was obtained from the farmers. Care was taken to obtain complete and fair estimates.

The form of blank for summarizing records in this office is shown on pages 440 to 443.

REGIONAL CONDITIONS

Broome County is one of the southern border counties of New York State. It is bounded on the east by Delaware County, on the west by Tioga County, on the north by Chenango and Cortland Counties, and on

the south by the State of Pennsylvania. It contains 705 square miles, 85 per cent of which is in farms. In 1920, according to preliminary returns for the fourteenth United States census, the population was 113,610. Binghamton, near the center of the county, the county seat and the only city of importance, had a population of 66,800. Three railroad lines — the Delaware, Lackawanna and Western, the Erie, and the Delaware and Hudson — serve the county. Binghamton furnishes a fair market

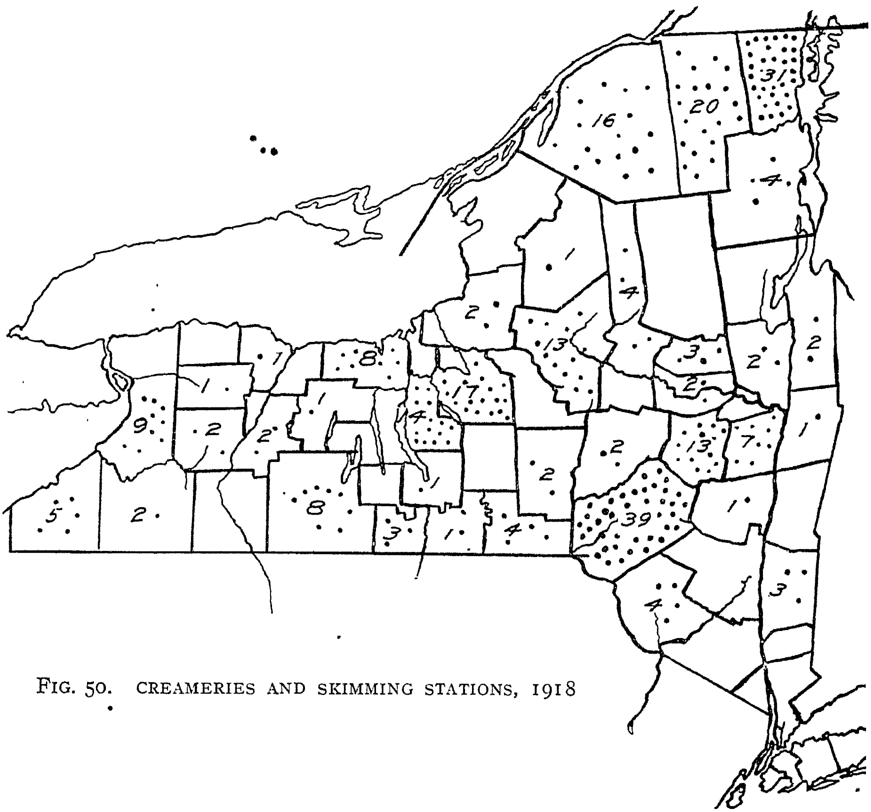

FIG. 50. CREAMERIES AND SKIMMING STATIONS, 1918

for a considerable amount of farm produce. Most of the surplus is shipped to New York City, 207 miles by rail.

The topography of Broome County is that of a feebly glaciated plateau region, thru which streams have cut deep valleys. Besides many small streams, three rivers of considerable size intersect the county, the Otselic joining the Tioughnioga at Whitney Point in the northern part, the Tioughnioga joining the Chenango at Chenango Forks, and the Chenango joining the Susquehanna at Binghamton. These river valleys are from one-half mile to almost two miles wide, and lie at an elevation of about 800 to 900 feet.

The valley soils are mapped as of the Chenango and Genesee series.[1] They are by far the more productive soils of the county, altho in some places adjacent to the rivers they are so low that crops are sometimes damaged or destroyed by floods out of season.

The land back from the valleys is rolling to steep. Much of the area is in woods, and a large proportion is suitable only for grazing. The highest elevations are in the southern part of the county, where the average level of the hilltops is about 1500 feet, altho the highest point is over 2000 feet.

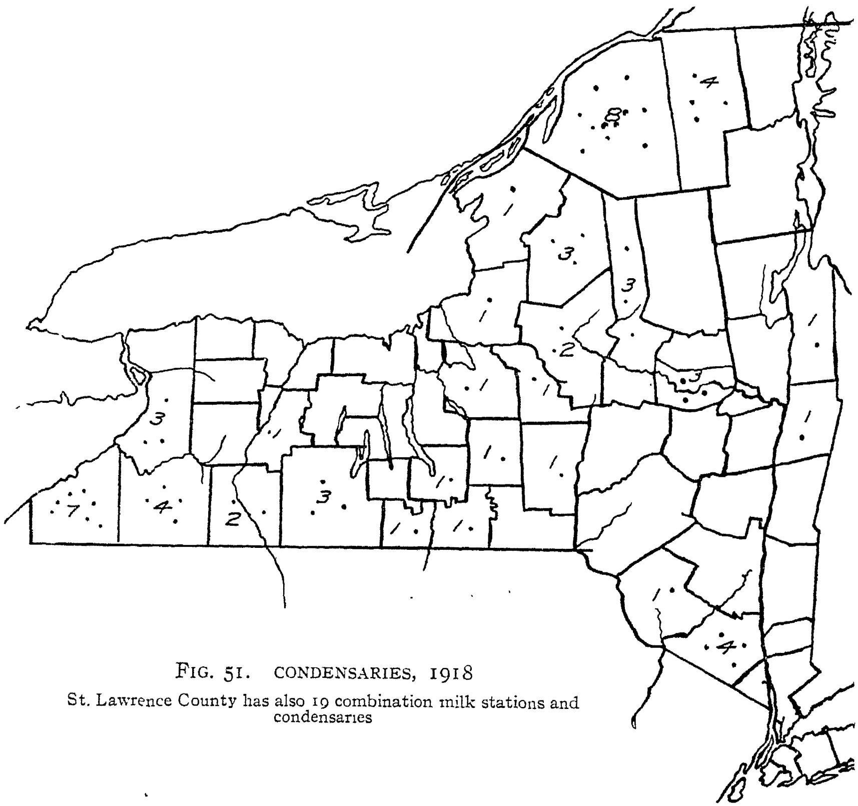

FIG. 51. CONDENSARIES, 1918
St. Lawrence County has also 19 combination milk stations and condensaries

Aside from small areas of alluvial soils in the stream valleys, the upland soils are generally of one type, Volusia silt loam. This is the most extensive and least productive type in the county. Its distinguishing characteristics are low humus content and low lime content. The compact subsoil or rock, generally lying close to the surface, makes drainage conditions unfavorable to the best crop production.

Weather records give the mean annual temperature at Binghamton, 871 feet above sea level, for the years 1890 to 1916 inclusive, as 46.8° F.,

[1] Field operations of the Bureau of Soils. United States Agr. Dept. Report 11: 71–96. 1905. Soils of the United States. United States Soils Bureau. Bul. 96: 744. 1913.

and the average rainfall as 33.18 inches. About half of the rain, 15.61 inches, falls from April to August inclusive. Much of the summer rainfall comes in heavy showers which quickly run off, and drouths are somewhat frequent, so that pastures often need to be supplemented during August and September.

The average length of the growing season at Binghamton for the years mentioned was 150 days.[2] The average date of the last killing frost in the spring was May 6, and of the first killing frost in the fall October 3. Altho there are no weather records for the uplands of this county, the growing season there averages from two to three weeks shorter. This makes the pasture season shorter, and the frost injury to crops, particularly to corn, more extensive, on the hills.

There are three types of farming common in Broome County — general farming, dairy farming, and trucking for the local markets.

Most of the trucking is confined to the valleys near the principal towns, while general and dairy farming is found both in the valleys and on the hills. The farms on the Volusia soil are devoted primarily to the production of forage crops and to dairying. On a few, potatoes are grown as a cash crop, but in general the land is too poor and the season too short to grow other intensive crops. The distance to market is much greater from the farms on the uplands, and this factor also influences the type. Everything considered, dairying is the best type of farming for the upland conditions.

According to the thirteenth census the average farm in the county in 1910 contained 102 acres. Of this, 35 acres were in crops exclusive of fruit, 22 in woods, and 45 in pasture and other land. Of the crop land, 27 acres were in hay and forage. The other principal crops are corn, oats, buckwheat, and potatoes. These crops are typical of the farms studied.

Altho Broome County may be considered a leading dairy county of the State, many dairymen, especially those of the uplands, follow an extensive system. An abundance of pasture, a short growing season, and a soil that is not naturally fertile, encourage the summer system. The industry never has been so intensively developed here as it has in the neighboring counties of Delaware and Chenango, or in many other counties of the State. This may be due mostly to less productive soil.

During the past thirty years the system of dairying has become increasingly more intensive. In 1880 there were 29,398 dairy cows two years old or older on farms in the county, and 3,659,982 pounds of butter made on farms.[3] In 1917 there were 27,029 dairy cows on 3027 farms in the county, an average of 8.9 per farm reporting dairy cows.[4] The

[2] Climatological data, New York section, August, 1916, page 94.
[3] United States census report, 1880.
[4] Census of the agricultural resources of New York, 1917.

United States census of 1910 reported 410,291 pounds of butter made on farms in the county during 1909. In 1900 there were twenty milk stations in the county, and in 1916 there were forty.[5]

The making of butter and cheese has practically ceased. This has resulted in more winter milk. The next step in the development of a more intensive system of dairying in the region will be the production of

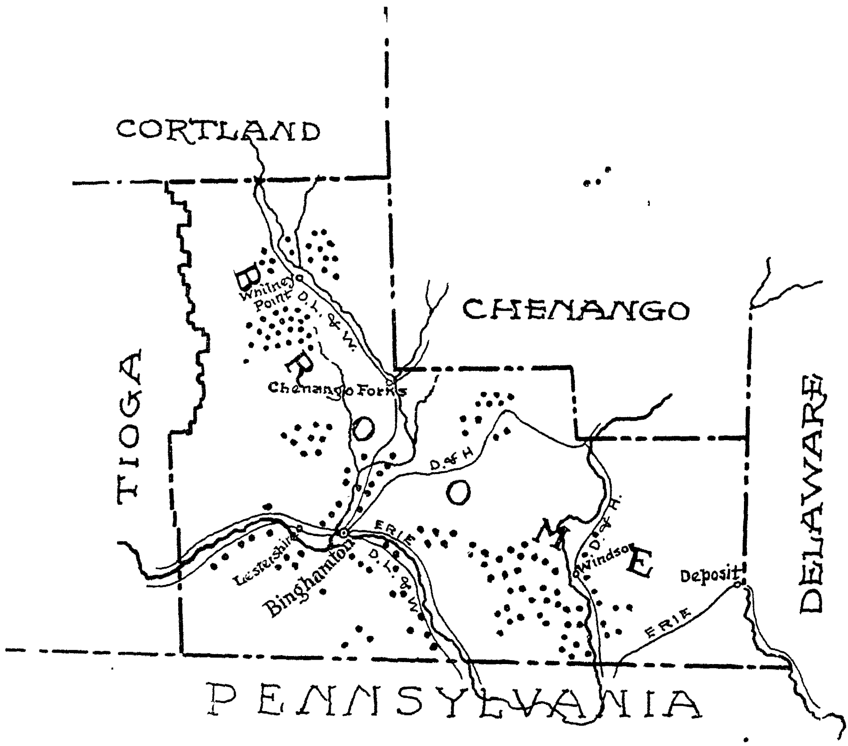

FIG. 52. MAP OF BROOME COUNTY SHOWING LOCATION OF FARMS STUDIED

Of the 149 farmers, 104 owned all of the land they farmed, 6 owned part and share-rented additional land, 12 owned part and cash-rented additional land, and 20 share-rented and 7 cash-rented all of the land they farmed. The average number of acres per farm was 157, and the average distance to market was 3.4 miles. The average age of the farmers was 47 years

a still larger proportion of the milk in winter, as the demands of Binghamton and New York City for market milk continue to grow.

The farms included in this survey were in various parts of the county, but most of them were in the vicinity of Windsor, Whitney Point, and Binghamton. Fifty were in the Susquehanna, Chenango, and Otselic Valleys, and ninety-nine were on the hills or upland. Herds of less than six cows were not included, but other than this there was no selection.

[5] Bulletin 5, New York State Department of Agriculture, pages 4–5, 1900, and Bulletin 88, New York State Department of Agriculture, pages 3, 4, and 5, 1916.

RESULTS OF THE INVESTIGATION

For convenience the results of this study are arranged in five parts. Part I considers the entire dairy enterprise as the unit of study; Part II deals with cows only, Part III with heifers, Part IV with herd bulls, and Part V with veals and bulls to be sold.

PART I. CONCERNING THE ENTIRE ENTERPRISE

When the entire dairy enterprise is considered the unit, all the costs of maintaining cows, costs of growing and maintaining heifers, calves, veals, bulls to be sold, and herd bulls, costs of marketing dairy products, and any other costs for dairy cattle, are charged. All returns from the enterprise are credited and the difference is considered the gain or loss on the enterprise.

The dairy is only one of the various parts of a farm business, and therefore the results do not show the gain or loss on the whole farm. An investigation that included the labor income as well as costs and returns for the dairy would be useful.

Costs

The various costs chargeable to dairy cattle may be classified as follows: feed, bedding, labor, milk hauling, use of buildings, use of equipment, interest, and miscellaneous charges.

Feed

No account was taken of feed given to stock other than dairy cattle. The total quantities and costs of the various feedstuffs used by all dairy cattle, by cows during the pasture period, by heifers, by herd bulls, and by bulls raised to be sold, were obtained separately in the field. The feed used by cows during the winter period was considered to be the difference between the total herd quantities and the other quantities.

All grain, succulent feed, and forage raised on the farm and used by cattle, was charged at what it would sell for at the farm, that is, its market value less the cost of marketing. All feedstuffs purchased were charged at the prices paid. The cost of hauling to the farm was included with labor, equipment, milk hauling, and other costs. Much of the purchased grain is hauled home by the farmer when returning from delivering the milk. This was included with the charge for milk hauling. Extra trips for feed, as well as the time spent hauling home-grown grains to and from the mills and the time spent mixing feed, was charged under labor.

Grain and other concentrates.— With grain and other concentrates were included all concentrated feedstuffs, namely, all grains and their by-products whether home-grown or purchased, calf meal, condimental feeds, and salt (table 1). The charge for grain represented 36 per cent of the total feed cost and 20 per cent of the total cost of the enterprise.

On the 149 farms there were six different kinds of grain raised and fed cattle, and at least forty-three different kinds of grain purchased and fed.

TABLE 1. CONCENTRATES USED BY 2058 COWS, 1002 HEIFERS, 172 HERD BULLS, AND 76 BULLS TO BE SOLD*

Kind of feed	All herds				Cows				Heifers			Herd bulls			Bulls to be sold		
	Number of herds using feed	Number of pounds used	Average price per ton†	Value	Number of pounds used	Per cent, omitting condimental feed and salt	Average price per ton	Value	Number of herds using feed	Number of pounds used	Value	Number of herds using feed	Number of pounds used	Value	Number of herds using feed	Number of pounds used	Value
Home-grown:																	
Oats	42	88,950	$30.92	$1,375	69,507	2.46	$30.01	$1,043	23	17,729	$302	9	1,714	$30	...	...	...
Buckwheat	17	27,430	33.69	462	25,220	0.89	33.54	423	2	1,970	35	1	240	4	...	...	...
Corn	7	14,140	27.44	194	13,640	0.48	27.13	185	...	...	...	1	500	9	...	...	...
Rye	1	2,800	44.29	62	2,240	0.08	44.64	50	1	560	12	...	...	...	...	...	...
Barley	1	1,700	35.29	30	1,250	0.05	35.20	22	1	400	7	1	50	1	...	...	...
Wheat	1	360	44.44	8	...	...	...	...	1	310	7	1	50	1	...	...	...
Total home-grown	...	135,380	$31.48	$2,131	111,857	...	$30.81	$1,723	...	20,969	$363	...	2,554	$45	...	...	...
Purchased:																	
Gluten (feed)	134	1,113,480	$30.38	$16,916	1,072,005	37.92	$30.36	$16,274	44	31,315	$470	43	10,160	$172	...	...	...
Cornmeal	60	160,490	32.28	2,590	125,440	4.44	32.27	2,024	33	25,095	405	32	9,955	161	...	...	...
Hominy	9	28,020	30.76	431	20,495	0.72	30.35	311	6	5,705	92	3	720	12	1	1,100	$16
Corn and oats	8	8,400	35.24	148	90	...	22.22	1	8	7,250	128	3	1,060	19	...	...	...
Corn bran	1	2,850	7.72	11	2,850	0.10	7.72	11	...	...	...	...	...	...	...	...	...
Corn middlings	1	1,880	18.09	17	1,880	0.07	18.09	17	...	...	...	...	...	...	...	...	...
Wheat feed	72	422,907	30.84	6,521	363,936	12.87	30.84	5,612	50	48,451	747	36	10,520	162	...	...	...
Wheat bran	65	262,700	28.52	3,746	235,235	8.32	28.56	3,359	38	21,975	308	28	5,490	79	...	...	...
Wheat middlings	33	19,200	32.92	316	7,650	0.27	30.59	117	28	10,815	186	7	635	11	1	100	2
Red dog middlings	2	700	34.29	12	...	...	...	...	2	600	11	1	100	1	...	...	...
Buckwheat middlings	6	25,300	30.99	392	25,000	0.88	31.04	388	1	300	4	...	...	...	...	...	...
Ground oats	5	8,200	33.90	139	3,400	0.12	31.76	54	3	2,900	52	3	1,900	33	...	...	...
Whole oats	1	800	37.50	15	...	...	...	...	1	700	13	1	100	2	...	...	...
Cottonseed meal	67	186,975	32.74	3,061	180,141	6.37	32.73	2,948	11	5,321	87	14	1,513	26	...	...	...
Oilmeal	44	15,200	42.37	322	7,660	0.27	45.43	174	31	7,130	139	7	410	9	...	...	...
Distillers' and brewers' dried grains:																	
Continental gluten	4	22,000	33.18	365	21,560	0.76	33.49	361	...	...	...	2	440	4	...	...	...
Dewey's	8	36,400	32.91	599	35,650	1.26	32.93	587	1	600	10	1	150	2	...	...	...
Kinds not found	6	12,500	32.96	206	11,480	0.41	32.93	189	1	720	12	1	300	5	...	...	...
Dry equivalent of brewers' grains, wet	2	60,206	15.28	460	60,206	2.13	15.28	460	...	...	...	...	...	...	...	...	...
Brewers' grains, dried	25	89,800	28.00	1,257	88,655	3.14	28.02	1,242	4	800	10	5	345	5	...	...	...
Malt sprouts	2	5,000	25.60	64	5,000	0.18	25.60	64	...	...	...	...	...	...	...	...	...

* The number of bulls to be sold is the number born during the year, plus the number purchased, less the number slaughtered or sold for slaughter.
† Average prices per ton are obtained by dividing the total value by the quantities used.

TABLE I (*concluded*)

Kind of feed	All herds				Cows				Heifers			Herd bulls			Bulls to be sold		
	Number of herds using feed	Number of pounds used	Average price per ton	Value	Number of pounds used	Per cent, omitting condimental feed and salt	Average price per ton	Value	Number of herds using feed	Number of pounds used	Value	Number of herds using feed	Number of pounds used	Value	Number of herds using feed	Number of pounds used	Value
Molasses and molasses feeds:																	
Molasses	8	9,900	$23 64	$ 117	9,900	0 35	$23 64	$ 117	....	.....	....	....	.....	....	....	.....	....
Cloverleaf Feed	17	80,600	26.18	1,055	72,690	2 57	26.14	950	7	5,680	$ 75	10	2,230	$30	....	.....	....
Hammond's Dairy	2	11,200	26.61	149	10,660	0 38	26.64	112	1	370	5	1	170	2	....	.....	....
Ideal	1	10,000	25.00	125	10,000	0.35	25 00	125	....	......	....	....	......	....	....	.....	....
International Special	1	10,000	22.00	110	10,000	0.35	22.00	110	....	......	....	....	......	....	....	.....	....
Purina	1	8,000	33 00	132	7,850	0 28	33 12	130	1	150	2	....	......	....	....	.....	....
Sucrene	2	5,600	30.71	86	5,600	0 20	30.71	86	....	......	....	....	......	....	....	.....	....
Xtra Vim	2	2,500	32.80	41	2,500	0.09	32 80	41	....	......	....	....	......	....	....	.....	....
Empress	1	2,000	23 00	23	2,000	0.07	23.00	23	....	......	....	....	......	....	....	.....	....
International Dairy Feed	1	30,500	24.98	381	28,000	0 99	24.93	319	1	2,200	28	1	300	4	....	.....	....
Sugar Feed	1	2,600	30.00	39	2,600	0 09	30.00	39	....	......	....	....	......	....	....	.....	....
Kinds not found	24	106,760	25.96	1,386	103,059	3.65	25 95	1,337	6	2,961	39	5	740	10	..	...	....
Other mixed feeds:																	
Eggee	4	27,800	24.82	345	25,740	0.91	25.02	322	2	1,580	19	2	480	4	...	.....	....
Schumacher	32	68,450	31.56	1,080	43,875	1.55	31.23	685	22	22,000	354	10	2,575	41	..	.....	....
Union grains (Ubiko)	3	49,000	32 65	800	48,900	1 73	32 64	798	..	......	....	1	100	2	..	....	....
Unicorn	7	43,300	33 86	733	39,920	1.41	33 87	676	1	2,500	42	2	880	15	....	..	....
Mixed feed (Ubiko)	1	20,000	32.00	320	....	....	......	......	1	17,400	278	1	2,600	42	....	..	....
Grandins' Mixed Feed	6	8,975	31.42	141	4,300	0 15	32.09	69	2	4,525	70	1	150	2	..	....	....
Kinds not found	1	2,800	33.57	47	2,800	0.10	33 57	47	....	......	....	....	......	....	..	....	....
Miscellaneous:																	
Dried beet pulp	7	16,400	27.07	222	16,300	0.58	27.12	221	1	100	1	....	......	....		....	....
Calf meal	63	16,150	59.07	477	......	......	......	......	63	14,574	426	21	1,426	46	4	150	$5
Alfalfa meal	1	100	40.00	2	100	0.01	40.00	2	...	......	....	....	......	....	....	....	....
Condimental feed	32	‡1,350	......	326	1,350	....	......	324	1	......	1	1	......	1	..	....	....
Salt	141	70,110	10 36	363	67,480	....	......	349	8	2,430	13	1	200	1	..	.....	....
Total purchased	...	3,087,103	$29.86	$46,088	2,783,957	100 00	$29.55	$41,135	....	246,147	$4,027	....	55,649	$903	...	1,350	$23
Total concentrates	....	3,222,483	$29.93	$48,219	2,895,814	....	$29.60	$42,858	....	267,116	$4,390	....	58,203	$948	....	1,350	$23

‡ Quantities reported for six farms only. On the others the quantities were too insignificant to note. Probably some of this expense should have been included under miscellaneous costs, as medicines, and so forth.

The usual practice is to buy all the grain. Only 53 farms raised any grain to feed cattle. Practically all of this was oats and buckwheat. Purchased grain represented 96 per cent of the quantity used, and at the average price of $29.86 a ton it represented also 96 per cent of the charge for grain used by dairy cattle. The average value of home-grown grain used was $31.48 a ton.

Succulent feed.— Silage, green corn, potatoes, cabbage, cabbage fodder, mangels, beets, turnips, carrots, apples, soiling crops, skimmilk purchased, and other feeds with a very high percentage of water, were classed as succulent feed. Brewers' grains wet were converted to their dry equivalent by considering 3.8 pounds of wet grains equal to 1 pound of dried grains, and were charged under grain rather than under succulent feed. Quantities, costs, and the number of farms using each kind of succulent feed, are given in table 2.

Corn silage was charged at $5 a ton. Under some conditions, the market value of silage should be used when charging it to another enterprise; but generally, in New York State, corn for the silo is not raised to be sold either as grain or as silage, and hence it should be charged at cost. There is no reason to believe that the cost of producing silage on the farms studied was less than this figure.

Of the 149 farms, 69, or 46 per cent, fed silage. On these farms, 4284 tons of corn silage and 20 tons of millet silage were fed dairy cattle. An agricultural census of the State taken in 1917 showed that 3027 farms in Broome County kept dairy cows and 1033 grew corn for the silo in 1916; thus, about one-third of the farms with dairy cows grew silage.

Other succulent feeds were charged at their estimated farm values. Of all the herds, 26, or 17 per cent, fed no succulent feed. Excepting 21.8 tons of skimmilk and 1.35 tons of potatoes purchased, all succulent feed was raised on the farms where fed.

Dry forage.— All hay, corn stover, straw, and other cured roughage was classed as dry forage. One per cent was purchased. Of this, 11 farms bought 42.75 tons of hay, and two other farms bought 12 tons of cornstalks. The amount fed to dairy cattle per farm was 35.4 tons, of which mixed hay constituted 63 per cent. The average value of dry forage per ton was $9.62. Details as to quantities, costs, and number of farms using each kind of dry forage, are given in table 3.

Pasture.— Most farms had sufficient pasture for their cattle. Of the 149 farmers, 45 paid $793 to pasture some of their cattle a part or all of the season, and 20 received $305 for stock taken in.

Pasture was charged at cost. In determining this cost, interest at 5 per cent and taxes at 0.5 per cent were charged on the value of the land pastured. Charges for labor and materials used in making and repairing pasture fences, in manuring when manure was hauled and applied, in fertilizing, reseeding, mowing brush or weeds, or in any other treatment

TABLE 2. SUCCULENT FEED USED BY 2058 COWS, 1002 HEIFERS, 172 HERD BULLS, AND 76 BULLS TO BE SOLD

Kind of feed	All herds				Cows			Heifers			Herd bulls			Bulls to be sold		
	Number of herds using	Number of tons used	Average price per ton	Value	Number of tons used	Average price per ton	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value
Home-grown:																
Corn silage	69	4,284	$ 5.00	$21,420	3,895.9	$ 5.00	$19,484	45	310.1	$1,548	39	78	$388	...	...	...
Millet silage	1	20	3.00	60	20	3.00	60	...	...	...	...	...	...	...	...	...
Corn (green)	50	417.75	2.68	1,118	411.95	2.67	1,100	5	5	15	2	0.8	3	...	...	...
Sweet corn	2	7	4.00	28	7	4.00	28	...	...	...	...	...	...	...	...	...
Turnips	20	126.65	4.67	592	106.35	4.29	456	3	19.5	134	1	0.8	2	...	...	...
Potatoes	36	70.73	7.20	509	70.03	7.21	505	2	0.25	2	1	0.45	2	...	...	...
Mangels	3	47.4	3.04	144	46.4	3.06	142	1	0.5	1	1	0.5	1	...	...	...
Carrots	3	7.6	10.79	82	7.6	10.79	82	...	...	...	...	...	...	...	...	...
Apples	1	4.8	4.17	20	4.8	4.17	20	...	...	...	...	...	...	...	...	...
Beets	2	0.5	10.00	5	0.5	10.00	5	...	...	...	...	...	...	...	...	...
Cabbage fodder	7	57	1.89	108	57	1.89	108	...	...	...	...	...	...	...	...	...
Cabbage	6	30.75	3.02	93	30.75	3.02	93	...	...	...	...	...	...	...	...	...
Green rowen	2	36	1.81	65	36	1.81	65	...	...	...	...	...	...	...	...	...
Millet	8	28	4.21	118	27.7	4.22	117	...	...	...	1	0.3	1	...	...	...
Oats and peas	6	27.5	3.24	89	27.5	3.24	89	...	...	...	...	...	...	...	...	...
Buckwheat	2	14	7.71	108	14.0	7.71	108	...	...	...	...	...	...	...	...	...
Oats, corn, and millet	1	9	3.00	27	9.0	3.00	27	...	...	...	...	...	...	...	...	...
Oats	1	2	5.00	10	2.0	5.00	10	...	...	...	...	...	...	...	...	...
Rye	1	1.5	5.33	8	1.5	5.33	8	...	...	...	...	...	...	...	...	...
Purchased:																
Skimmilk	21	21.8	3.53	77	...	...	...	21	18.69	64	5	1.39	6	2	1.72	$7
Potatoes	1	1.35	3.70	5	1.35	3.70	5	...	...	...	...	...	...	...	...	...
Total succulent feed	...	5,215.33	$4.73	$24,686	4,777.33	$4.71	$22,512	...	354.04	$1,764	...	82.24	$403		1.72	$7

TABLE 3. DRY FORAGE USED BY 2058 COWS, 1002 HEIFERS, 172 HERD BULLS, AND 76 BULLS TO BE SOLD

Kind of feed	All herds				Cows			Heifers			Herd bulls			Bulls to be sold		
	Number of herds using	Number of tons used	Average price per ton	Value	Number of tons used	Average price per ton	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value
Home-grown:																
Mixed hay	130	3,322.9	$10.28	$34,158	2,571.3	$10.27	$26,414	117	608.5	$6,262	101	143.1	$1,482	..	.	....
Timothy hay	35	557.5	10.84	6,046	445.95	10.82	4,826	22	86.0	931	17	24.65	278	1	0.9	$11
Clover hay	7	103	11.63	1,198	86.9	11.50	999	3	14.4	177	2	1.7	22	....	...	...
Clover hay (second cut)	8	36.5	11.73	428	20.1	12.29	247	5	13.9	153	2	2.5	28		.	...
Alfalfa	11	45.5	14.33	652	42.4	14.34	608	4	3.0	43	1	0.1	1	.	.	...
Oat hay	24	140.5	9.08	1,276	131.05	9.16	1,201	4	7.75	61	4	1.7	14		..	....
Oat and pea hay	20	137.0	9.40	1,288	125.2	9.33	1,168	5	10.1	103	2	1.7	17		...	....
Millet	18	106.0	9.13	968	87.8	9.02	792	5	15.25	146	3	2.95	30	..	..	....
Straw fed (oat)	22	62.5	4.86	304	53.75	4.91	264	8	7.15	35	4	1.6	5		...	....
Straw fed (buckwheat)	5	4.5	4.22	19	3.65	3.84	14	1	0.5	3	1	0.35	2	...		...
Corn stover	72	706.5	5.61	3,963	660.2	5.60	3,699	28	39.55	232	13	6.75	32	..	.	...
Purchased:																
Hay	11	42.75	10.88	465	42.75	10.88	465	..	...	...	...	.....	...	.	...	....
Cornstalks	2	12	2.08	25	12.0	2.08	25	..	...	...	..	.....	...	...	.	....
Total dry forage	...	5,277.15	$9.62	$50,790	4,283.05	$9.51	$40,722		806.10	$8,146	..	187.10	$1,911		0.9	$11

of the pasture, and money paid for the use of pasture, were included. The amount received for stock taken in to pasture was deducted to get the cost of pasturing the farmer's own stock. This cost on each record was apportioned to cows, heifers, herd bulls, horses, and sheep, on the animal-unit basis and according to the number of days pastured. Most of the pasture hired was for heifers and the amount paid was charged directly to them.

The average date of turning out in the spring was May 14, and that of beginning full barn feeding in the fall was October 19. This allowed an average of 159 days on pasture. The dates of turning out varied from May 1 to June 1. The dates of beginning to feed in the fall varied from September 15 to November 15. Usually the meadows were pastured after the hay was removed. They furnished considerable feed, especially on the river flats. For this no charge was made, altho such a charge should have been included. In late summer and early fall, pasture was frequently supplemented by grain or fodder or both. The dry matter in the feed used supplementary to pasture for cows was equivalent to the dry matter in ten days of winter feed. On this basis pasture furnished 149 days of full feed for cows.

An average of 53.2 acres to each farm was pastured. Since the average size of farm was 156.7 acres, 34 per cent of the land was in pasture. The average value was $20.25 an acre. On the average 3.1 acres were pastured per animal unit.

The cost of pasture was $4.83 per cattle unit for the season, or 3.04 cents a day. Of this, interest and taxes comprised 72 per cent, and fencing costs 20 per cent. The balance was cash paid for hired pasture and other miscellaneous items. The charge for stock taken in to pasture was at the rate of $6.30 an animal unit for the season, or about 4 cents a day.

A summary of pasture costs is given in table 4. Stock pastured, and the distribution of the cost of pasture, are given in table 5.

TABLE 4. COST OF PASTURE, 2018 COWS, 607 HEIFERS, 106 HERD BULLS, 199 SHEEP, AND 124 HORSES AND COLTS

7,927.5 acres of pasture land at $20.25 = $160,509

Item	Farms having expense	Cost
Interest and taxes at 5.5 per cent	149	$8,828
Making and repairing fences	147	2,395
Mowing and reseeding	5	69
Fertilizing and manuring	2	165
Amount paid for pasture rented	45	793
Total	....	$12,250
Received for pasture	20	305
Difference (= cost of pasture)	....	$11,945

TABLE 5. STOCK PASTURED, AND DISTRIBUTION OF PASTURE COST

Kind of stock	Number of farms pasturing	Number of animals pastured	Average number of days pastured to each farm pasturing	Equivalent in animal units for entire season	Amount charged
Stock owned:					
Cows	149	2,018	159	2,018.5	$9,338
Heifers	122	607	146	305.7	1,907
Herd bulls	100	106	131	76.1	346
Total cattle	....	2,731	....	2,400.3	$11,591
Sheep	8	199	134	31.3	106
Horses and colts	52	124	99	64.8	248
Total owned	....	3,054	....	2,496.4	$11,945
Stock taken in:					
Mature	11	19	133	15.9	....
Young	12	68	152	32.5	....
Total	....	3,141	....	2,544.8	....

Acres of pasture per animal unit, 3.1.
Cost for each cattle unit of farmer's own stock, $4.83.

Bedding

Waste hay and stover from the mangers furnished a considerable quantity of bedding. No charge was made for this, since it was charged to the cattle as forage. Very little bedding was purchased. The bedding cost was apportioned to cows, heifers, and herd bulls on each farm. The data are given in table 6:

TABLE 6. BEDDING USED BY 2058 COWS, 1002 HEIFERS, AND 172 HERD BULLS

Kind of bedding	All herds			Cows		Heifers		Herd bulls	
	Number of farms using	Amount (tons)	Value	Number of farms using	Value	Number of farms using	Value	Number of farms using	Value
Home-grown:									
Oat straw	90	269.3	$1,483	92	$1,171	65	$225	51	$87
Buckwheat straw	21	32.7	105	22	101	1	4	.....	0
Wheat straw	1	0.5	2	1	2	.....	0	.....	0
Rye straw	1	3.0	24	1	18	1	2	1	4
Chaff	6	?	27	6	17	2	6	3	4
Swamp and marsh hay	6	9.5	50	5	40	3	8	2	2
Sawdust	9	?	22	8	22	.....	0	.....	0
Total home-grown	.....	......	$1,713	.....	$1,371	.....	$245	.....	$97
Purchased:									
Sawdust	52	?	$315	51	$275	12	$28	8	$12
Shavings	5	?	26	5	18	1	5	1	3
Buckwheat straw	1	?	14	1	2	1	10	1	2
Oat straw	3	?	12	2	7	2	4	1	1
Total purchased	.....	......	$367	.....	$302	.....	$47	.....	$18
Total bedding	.....	......	$2,080	.....	$1,673	.....	$292	.....	$115

Labor

Some farmers hauled their own milk, while many hired it hauled. Some spent considerable time in making and repairing pasture fences or in constructing and repairing buildings, while others spent little. For these reasons it was thought best to include such time under charges for milk hauling, pasture, and use of buildings, rather than under labor.

Excepting this, and also time spent in raising and harvesting crops and time spent hauling manure from the barnyard, all human and horse labor for the dairy enterprise was charged under the heading *Labor*. This includes all labor in milking, taking care of milk and dairy equipment, feeding, cleaning cattle and stables, hauling and mixing feed, hauling bedding, buying and selling cattle, and all other time spent for cattle. Not only was this labor divided as to whether it was spent for cows, for heifers, or for herd bulls, but it was also divided according to whether it was spent during the pasture period or during the winter period. The average wage of male farm labor without board in New York in 1915 was $35.80 a month.[6] This is about fifteen cents an hour for a nine-hour day, but probably is too low because use of house, wood, and other things furnished are not included in all cases. Farm operators, however, could ordinarily hire out to operate farms at more than hired men's wages; and their time, therefore, should be counted at a higher rate. The time of women and children usually is not so valuable as the time of men.

The cost of labor per hour depends largely on the size of the business, on the layout of the farm, on the type and intensity of farming, and on wages. Other things being equal, the rates are usually higher on the one-man farms than on the two-man farms. But since no records of the cost of labor on these farms were available, it was necessary to charge labor to dairy cattle at the same rate on each farm, irrespective of the variations mentioned.

Man labor was charged at 15 cents an hour. Since no records of any kind were available to show what woman and child labor cost, it was charged at 10 cents an hour. Horse labor was charged at 15 cents an hour.

The data for labor costs are given in table 7 (page 288).

Milk hauling

In order to make comparisons between farms that hired milk hauled and those where milk was hauled by the farmer, the cost of hauling milk was kept separate from other costs.

When the farmer drew his own milk only, or when he cooperated with neighbors in hauling, the cost was found by multiplying the hours of human and horse time required by the same rates per hour as were used for other labor.

[6] United States Department of Agriculture. Monthly crop report, March, 1917, page 25.

TABLE 7. LABOR CHARGES, 2058 COWS, 1002 HEIFERS, AND 172 HERD BULLS

Labor for	Pasture period, 159 days			Winter period, 206 days			Total				
	Number of farms using	Hours spent	Per cent	Number of farms using	Hours spent	Per cent	Number of farms using	Hours spent	Per cent	Value	Per cent
Cows:											
Human labor:											
Milking:											
Man	147	70,159	59	149	86,585	38	149	156,744		$23,511.60	
Woman	36	8,640	7	26	7,819	4	37	16,459	54	1,645.90	53
Child	25	5,254	5	20	6,897	3	26	12,151		1,215.10	
Care of cows, product, and utensils:											
Man	135	26,420	22	148	107,157	47	148	133,577		20,036.55	
Woman	120	6,185	5	121	8,285	4	121	14,470	44	1,447.00	45
Child	15	1,775	2	8	3,095	1	18	4,870		487.00	
Hauling feed	1	35	......	102	4,014	2	103	4,049		607.35	
Other human labor for cows	9	618	......	26	2,432	1	32	3,050	2	457 50	2
Total human labor for cows	......	119,086	100	......	226,284	100	......	345,370	100	$49,408.00	100
Horse labor for cows	1	16	......	119	11,263	......	119	11,279	......	$1,691.85	......
Heifers:											
Human labor	75	4,696	......	142	23,038	......	144	27,734	......	$4,160.10	......
Horse labor	1	10	......	48	1,249	......	49	1,259	......	188.85	......
Herd bulls:											
Human labor	34	1,145	......	120	6,852	......	122	7,997	......	1,199.55	......
Horse labor	......	....	......	5	37	......	5	37	......	5.55	......
Total human labor	......	124,927	......	......	256,174	......	......	381,101	......	$54,767.65	......
Total horse labor	......	26	......	......	12,549	......	......	12,575	......	1,886.25	......

TABLE 8. Charges for Hauling and Delivering to the Milk Stations 104,732 Hundredweight of Milk

Labor used	Total				Time spent hauling independently			Time spent hauling in cooperation		
	Number of farms using	Hours spent	Value: Total	Value: Per cent	Number of farms using	Hours spent	Value	Number of farms using	Hours spent	Value
Human labor:										
Man	88	36,697	$5,504.55	......	68	30,816	$4,622.40	22	5,881	$882.15
Boy	5	1,540	154.00	......	5	1,540	154.00	......	......	....
Girl	2	1,092	109.20	......	2	1,092	109.20	......	......	....
Woman	9	1,008	100.80	......	8	918	91.80	1	90	9.00
Total human labor	......	40,337	$5,868.55	29.8	69	34,366	$4,977.40	22	5,971	$ 891.15
Horse labor	......	58,390	8,758.50	44.5	69	46,912	7,036.80	22	11,478	1,721.70
Paid for hauling	87	......	5,057.74	25.7	......	......	....	......	......	....
Total	149	......	$19,684.79	100.0	69	......	$12,014.20	22	......	$2,612.85

All charges for the use of the milk wagon, cans, and other equipment used in hauling milk, were included under dairy equipment, rather than under milk hauling. The charge, therefore, includes no expense for use of equipment. When the farmer hired his milk hauled, the money paid was considered the cost of hauling. Whenever a combination of methods was used, the cost was found by adding the cash cost to the farmer's labor charge for hauling.

At the rates used in this study, human labor made up 29.8 per cent, horse labor 44.5 per cent, and cash paid 25.7 per cent, of the cost of hauling the milk. Milk-hauling charges made up 8.2 per cent of the total charges to the enterprise. Of the total time spent, only 14.8 per cent was in cooperation with neighbors.

The figures for milk-hauling costs are given in table 8.

Use of buildings

Values at the beginning and at the end of the year, of the silos, milk houses, ice houses, and those parts of the barns and other buildings used by dairy cattle, or in storing all feed except dry forage used by them, are given in table 9:

TABLE 9. VALUE OF BUILDINGS, 2058 COWS, 1002 HEIFERS, 172 HERD BULLS, AND 76 BULLS TO BE SOLD

Buildings	May 1, 1914		May 1, 1915	
	Number of farms reporting	Value	Number of farms reporting	Value
Dairy and cattle barns*	149	$127,612	149	$128,577
Silos	54	8,932	60	9,777
Milk houses	122	4,708	124	4,821
Ice houses	94	3,494	95	3,507
Total	....	$144,746	....	$146,682

Average value, $145,714.
Increase in value, $1,936.

* Includes 9 silos built in barns.

The average of these values was $145,714, or about $978 per farm. During the year six new silos were erected, so that at the end of the year about 40 per cent of the farms had silos not built inside the barns. The number of silos does not agree with the number of farms feeding silage, for the reason that on some farms the silos were built in the barns and were included with the value of the barn. Most of the farms have milk houses separate from the barns, and 64 per cent have separate ice houses, altho

108 farmers used ice. Often one building is used as both a milk house and storage for ice.

The charge for the use of buildings was made up of interest at 5 per cent on the average value, the cost of new buildings, cost of repairs, insurance, and decreased value. When buildings were worth more at the end of the year, the increase in value was deducted to determine the charge for their use. This was then apportioned to cows, to heifers, to herd bulls, and to bulls to be sold, according to the average number of cattle units of each class on hand at the beginning and at the end of the year.

The data for use of buildings are given in table 10:

TABLE 10. CHARGES FOR USE OF BUILDINGS, 2058 COWS, 1002 HEIFERS, 172 HERD BULLS, AND 76 BULLS TO BE SOLD

	Number of farms reporting	Amount
New buildings and building repairs:		
Purchased lumber	7	$ 287.40
Shingles and roofing	18	565.00
Paint and glass	40	427.70
Hardware	3	113.60
Materials from farms	17	424.50
Sand and gravel	6	21.25
Cement	9	200.40
Labor:		
Hired	18	942.45
Farm	26	516.16
Horse	7	74.20
Board of labor	6	26.50
New buildings, labor and materials	10	1,911.50
Total	86	$5,510.66
Interest on $145,714 at 5 per cent	....	$7,285.70
Insurance	....	455.00
Total	....	$13,251.36
Less increase in value*	....	1,936.00
Net charge	....	$11,315.36

Apportionment of cost

	Number of farms having expense	Amount charged
Cows	149	$8,705.69
Heifers	146	2,143.21
Herd bulls	126	464.46
Bulls to be sold	1	2.00

* Depreciation on buildings, 2.45 per cent of average value.

Use of equipment

The value of the different kinds of equipment used by dairy cattle, on hand at the beginning and at the end of the year, and the number of farms having each kind, are given in table 11:

TABLE 11. VALUE OF EQUIPMENT USED BY 2058 COWS, 1002 HEIFERS, AND 172 HERD BULLS

	May 1, 1914		May 1, 1915	
	Number of farms	Value of equipment	Number of farms	Value of equipment
Milk cans	120	$1,040	122	$ 997
Coolers	10	30	11	34
Testers, bottles, and scales	17	44	18	46
Separators	15	311	16	323
Churns and workers	40	85	40	85
Bottles and containers	7	11	7	11
Milk wagons	90	1,710	92	1,686
Milking machines	....	....	1	250
Ice tools	91	237	91	236
Feed cutters	1	25	1	25
Pumps	1	3	1	3
Root cutters	4	10	2	6
Grinders and engines	10	788	14	794
Milk pails and strainers	147	314	148	332
Extra calf pails	31	33	33	34
Clipping machines	24	115	28	141
Veterinary outfits	11	21	13	25
Forks, shovels, and other barn tools	126	360	122	364
Wheelbarrows and trucks	41	103	47	114
Staffs and halters	22	23	24	28
Total	....	$5,263	....	$5,534

Average value, $5,398.
Increase in value, $271.

More than three-fifths of the value of equipment is in milk cans, pails, strainers, and other dairy utensils, and wagons used in hauling milk. The farmers, with the exception of the patrons of one company, owned the cans they used. Since much of this equipment is in daily use, it requires frequent repairing and must be replaced often. Hence its upkeep represents the largest part of the annual cost of dairy equipment.

The charge for the use of equipment includes interest at 5 per cent on the average value at the beginning and at the end of the year, cost of equipment purchased during the year, repairs on equipment, and decreased value less any increase in value. This cost was apportioned for each farm, to cows, to heifers, and to herd bulls, according to the number of animals and the amount of equipment used by them. The charges are given in table 12:

TABLE 12. Charges for Use of Equipment, 2058 Cows, 1002 Heifers, and 172 Herd Bulls

	Number of farms having expense	Amount
Interest on $5,398 at 5 per cent*	149	$ 269.90
Equipment purchased	133	1,079.30
Repairs	76	230.00
Total	....	$1,579.20
Less increase in value	....	271.00
Net charge	....	$1,308.20

Apportionment of cost

	Number of farms having expense	Amount charged
Cows	149	$1,015.10
Heifers	138	221.45
Herd bulls	102	71.65

* Depreciation, 19.2 per cent of average value.

Interest

Separate interest charges at 5 per cent were made on the average value of cattle and on the average investment in feed and supplies kept on hand for cattle. As previously indicated, the other interest charges were included under use of pasture, use of buildings, and use of equipment.

The average value of cows, heifers. and herd bulls was $163,124. Due to averaging each record separately, the value here used is $163,109,

TABLE 13. Interest on Average Value of 2058 Cows, 1002 Heifers, and 172 Herd Bulls

Kind of stock	Average number from inventory	Average value from inventory	Value used in charging interest	Interest at 5 per cent	Number of farms having expense
Cows	2,058	$133,152	$133,148	$6,657.40	149
Heifers under one year	532.5	7,296	23,626	1,181.30	146
Heifers one year or over	469.5	16,338			
Bull calves to be kept	67	1,074	6,335	316.75	126
Herd bulls one to two years	59.7	2,162			
Herd bulls over two years old	45	3,102			
Total	....	$163,124	$163,109	$8,155.45	....

the interest on which amounts to $8155.45. Since veals and bulls to be sold are kept on hand for only a short time, no interest was charged on their value. The data are given in table 13.

Interest was charged to the dairy enterprise on the investment in forage for the average length of time the forage was stored before it was fed, and on the investment in concentrates from the time they were paid for until they were fed. On each record this cost was distributed to cows, heifers, and herd bulls, according to the numbers of animals kept and the quantities of feed used. The average total capital so invested was $38,160, or about $256 per farm. On some farms keeping heifers and herd bulls the interest charge on feed and supplies was so small that it was not separated. The data are given in table 14:

TABLE 14. INTEREST ON AVERAGE VALUE OF FEED AND SUPPLIES KEPT ON HAND FOR 2058 COWS, 1002 HEIFERS, AND 172 HERD BULLS

All herds			Cows		Heifers		Herd bulls	
Average value of feed and supplies on hand	Number of farms having expense	Interest at 5 per cent	Number of farms having expense	Amount charged	Number of farms having expense	Amount charged	Number of farms having expense	Amount charged
$38,160	149	$1,908	149	$1,511.50	120	$305.50	81	$91.00

Miscellaneous costs

All remaining expenses were classed as miscellaneous costs, and are given in table 15. Of these, ice, veterinary fees, medicines and disinfectants, fly protectors, whitewash, and expenses for testing milk, were the most important. Farmers having the expense for milk testing estimated the portion of this expense that should be charged to cows, to heifers, to bulls to be sold, and to herd bulls. The same was done with other items not wholly chargeable to cows.

The average amount of ice stored per cow was 1949 pounds.

Returns

Returns from dairy cattle on the farms studied were classified as (1) milk and milk products, (2) appreciation on cattle, (3) manure recovered, (4) miscellaneous returns.

Milk and milk products

Milk sold.— Of the 149 farms, 52 sold to the Empire State Dairy Company at Windsor and 1 to this company at Oquaga, 39 sold to Cloverdale Farms Company at Binghamton, 18 sold to F. W. Jansen at Whitney's Point, 16 to Bordens' at Tunnel, 7 to Sheffield Farms, Slawson-Decker Company, at Conklin, 5 to Bordens' at Whitney's Point, 3 to the Broome County Dairy Company at Binghamton, 7 a part of the year to F. W.

TABLE 15. MISCELLANEOUS COSTS, 2058 COWS, 1002 HEIFERS, 172 HERD BULLS, AND 76 BULLS TO BE SOLD

Item	All herds		Cows		Heifers		Herd bulls		Bulls to be sold	
	Number of farms having expense	Cost	Number of farms having expense	Cost	Number of farms having expense	Cost	Number of farms having expense	Cost	Number of farms having expense	Cost
Ice, 2006 tons	108	$1,711	108	$1,711	......	......	......	......	......	......
Veterinary fees	51	347	50	327	3	$20	......	......	......	......
Medicines, disinfectants, and louse killers	84	259	82	235	17	23	1	$1		
Fly protectors	107	268	107	259	5	5	4	4	......	......
Whitewashing	105	317	105	307	3	9	1	1	......	......
Milk testing, acids, etc	17	322	16	248	10	74	......	......	......	......
Insurance on cattle	104	176	104	162	12	13	1	1	......	......
Feed grinding and freight	34	100	26	81	11	16	3	3	......	......
Registration and transfer fees	6	31	......	......	3	13	2	5	2	$13
Express on stock	3	3	2	2	......	......	1	1	......	......
Advertising	1	2	......	......	......	......	......	......	1	2
Sawdust for ice	19	53	19	53	......	......	......	......	......	......
Hauling feed	3	16	3	14	1	1	1	1	......	......
Hauling bedding	2	18	2	15	1	2	1	1	......	......
Gasoline, oil, and batteries	3	33	3	28	2	4	1	1	......	......
Fuel for water heater	2	13	2	11	1	2	......	......	......	......
Clipping	12	17	12	16	......	......	1	1	......	......
Lime	1	1	1	1	......	......	......	......	......	......
Board of cows	1	26	1	26	......	......	......	......	......	......
Total	......	$3,713	......	$3,496	......	$182	......	$20	......	$15
Breeding fees	28	$183	28	$183	......	......	......	......	......	......

Jansen and a part of the year to Bordens' at Whitney's Point, and 1 a part of the year to Cloverdale Farms Company and a part of the year to the Broome County Dairy Company at Binghamton. Milk sold to Cloverdale Farms and the Broome County Dairy Company was used in Binghamton, while the remainder was for the New York market.

Practically all milk was sold on six-months contracts made with the milk companies on October 1 and April 1. All concerns except two paid a flat price for milk containing a minimum percentage of butterfat. This per cent was 3.7 for one concern, and 3.8 and 4 per cent for the others. A premium was paid when the milk tested above a certain percentage specified in the contract. The monthly prices paid by three companies are given in table 16. Prices paid by the other companies were about the same.

TABLE 16. MONTHLY PRICES PAID FOR MILK BY THREE COMPANIES, PER HUNDREDWEIGHT

	Company no. 1	Company no. 2	Company no. 3
1914:			
May	$1.20	$1.05	$1.25
June	1.10	1.00	1.20
July	1.35	1.15	1.35
August	1.55	1.30	1.50
September	1.80	1.40	1.60
October	1.95	1.70	1.90
November	2.05	1.80	2.00
December	2.05	1.80	2.00
1915:			
January	1.95	1.75	1.95
February	1.80	1.65	1.85
March	1.75	1.60	1.80
April	1.50	*1.55	1.50
Per cent of butterfat required	†4.0	3.7 (for April, 3.8)	
Barn score required:			
Equipment	25	25	....
Methods	45	43	....
Premiums in addition to above:			
Butterfat	10 cents a hundred pounds if 4.5 per cent or better	10 cents a hundred pounds if 3.8 per cent or better	3 cents a hundred pounds if 4.1 to 4.5 per cent inclusive
Barn score	2 cents a hundred pounds for each 5 points above 70	10 cents a hundred pounds if score 25 on equipment, 43 on methods	None

* For 3.8-per-cent milk with barn score.
† Average for year.

With one exception, each concern had an inspector visit and score the premises at regular intervals. A premium was paid by some of the companies for a higher score. This encouraged the production of clean milk. One company furnished the lime and equipment, and assisted the

TABLE 17. RETURNS FROM MILK SOLD, 2058 COWS

	Number of farms selling	Number of pounds of milk sold	Per cent of total milk sold	Number of pounds of fat in milk	Average per cent of butterfat	Average amount received for 100 pounds of milk sold	Total amount received for milk sold	Per cent of total amount received
1914:								
May	149	1,263,511	12.1	49,277	3.9	$1.28	$16,176.20	9.4
June	149	1,277,921	12.2	49,839	3.9	1.21	15,427.53	9.0
July	149	1,031,219	9.8	41,249	4.0	1.36	14,038.80	8.2
August	148	804,535	7.7	32,986	4.1	1.55	12,468.13	7.3
September	149	729,411	7.0	30,635	4.2	1.69	12,322.50	7.2
October	149	757,937	7.2	31,833	4.2	1.96	14,858.83	8.7
November	149	678,288	6.5	28,488	4.2	2.06	13,955.19	8.1
December	147	710,820	6.8	29,854	4.2	2.06	14,668.57	8.6
1915:								
January	142	735,854	7.0	29,434	4.0	2.00	14,693.08	8.6
February	140	674,841	6.4	26,319	3.9	1.88	12,700.94	7.4
March	140	813,750	7.8	31,736	3.9	1.80	14,673.42	8.5
April	146	924,341	8.8	36,049	3.9	1.51	13,941.59	8.1
Retail	53	70,798	0.7	2,974	4.2	2.30	1,627.44	0.9
Total or average	....	10,473,226	100.0	420,673	4.0	$1.64	$171,552.22	100.0

farmers in whitewashing their barns twice a year, without charge. The figures for the returns from milk sold are given in table 17.

Milk products sold.— Only seven farms sold butter, and one farm sold 200 pounds of cream. The figures are given in tables 18 and 19.

Milk and milk products used.— The value of all milk used on each farm was calculated by multiplying the number of pounds used by the weighted average price received for all milk sold from the farm. Some farmers

TABLE 18. RETURNS FROM MILK PRODUCTS SOLD AND MILK AND ITS PRODUCTS USED ON FARMS, 2058 COWS

	Number of farms	Number of pounds of product	Number of pounds of fat	Price	Total value	
Milk products sold:						
Butter	7	1,015	863	$0.31	$312.76	
Cream	1	200	40	1.50	30.00	
Total milk products sold	......	....	....	......	....	$342.76
Milk used:						
Family	147	313,048	12,522	$1.63	$5,103 33	
Hired men	14	17,638	706	1.72	304.16	
Milk products used:						
Skimmilk:						
Hogs	10	30,700	....	0.20	59.97	
Poultry	1	2,200	....	0.15	3.30	
Buttermilk:						
Family use	21	7,264	....	0.22	15.93	
Hogs	10	3,250	....	0.23	7.50	
Poultry	1	100	....	0.20	0.20	
Butter, family use	36	5,656	4,808	0.29	1,633.97	
Cream, family use	11	1,000	200	1.81	180 64	
Total milk and its products used, except that fed cattle	......	....	19,139	......	....	$7,309.00
Equivalent in pounds of milk*	......	371,457	....	......	....	
Milk used:						
Heifers	134	215,464	8,619	$1.63	$3,517.77	
Veals and bulls to be sold	94	193,535	7,741	1.62	3,126.91	
Bull calves to be kept for herd bulls	65	26,275	1,051	1.63	429.47	$7,074.15
Milk products used:						
Skimmilk:						
Heifers	32	96,068	....	$0.18	$171.17	
Veals and bulls to be sold	4	3,072	....	0.20	6.16	
Bull calves to be kept for herd bulls	8	6,493	....	0.17	11.08	$188.41
Buttermilk:						
Heifers	3	1,300	....	$0.19	$2.45	$2.45
Total milk and its products fed cattle	......	....	17,411	......	....	$7,265.01
Equivalent in pounds of milk*	......	540,907	....	......	....	....

* Excluding buttermilk.

fed more milk in months when the price was below the average price for the year, and others fed more when the price was above the average. But the quantity used in the house was practically uniform thruout the season. Since the months in which milk was used were not ascertained, it was necessary to use the average yearly price. The prices used in calculating the value of skimmilk and buttermilk were those furnished by the farmers. An average of 2130 pounds of milk per family was used. The figures are given in table 18 and summarized in table 19.

TABLE 19. Summary of Returns from Milk Products Sold and Milk and Its Products Used on Farms, 2058 Cows

	Milk		Skimmilk		Buttermilk		Butter		Cream		Equivalent in whole milk*	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Total used, except that fed cattle	330,686	$5,407.49	32,900	$ 63.27	10,614	$23.63	5,656	$1,633.97	1,000	$180.64	370,242	....
Total fed cattle	435,274	7,074.15	105,633	188.41	1,300	2.45	...	......	....	.....	540,907	....
Total used on farms	765,960	$12,481.64	138,533	$251.68	11,914	$26.08	5,656	$1,633.97	1,000	$180.64	911,149	....
Milk products sold	....	....	....	....	......	.....	1,015	312 76	200	30.00	1,215	....
Total	765,960	$12,481.64	138,533	$251.68	11,914	$26 08	6,671	$1,946 73	1,200	$210 64	912,364	$14,916.77

* Excluding buttermilk.

Appreciation on cattle

On most farms where dairy cattle are raised to replace those that die and those that are sold, the increased value of young cattle exceeds the depreciation and all losses due to death. On the farms studied, this excess, or appreciation, amounted to $27,988, or 12 per cent of the returns from cattle. Appreciation and depreciation were calculated in the following manner:

When considering the entire herd as a unit, cattle were charged with the first inventory and all purchases of dairy cattle. They were credited with cattle sold or used, hides, and the second inventory.

Cows were charged with the inventory at the beginning, cows purchased, and heifers that became cows. They were credited with cows sold or slaughtered, cow hides, and the inventory at the end.

Heifers were charged with the first inventories, heifers purchased, and value at birth of heifers born during the year. They were credited with heifers sold and slaughtered, value at time of freshening of heifers that freshened during the year for the first time, heifer hides, and the inventories at the end.

Herd bulls were charged with the inventories at the beginning, herd bulls purchased, and value at birth of bull calves born during the year and to be kept for future service. They were credited with herd bulls sold or slaughtered, hides, and the inventories at the end.

Veals and bulls to be sold were charged with the inventories at the beginning, purchases, and value at birth of veal calves and of bulls to be sold that were born during the year. They were credited with veals and bulls sold or slaughtered, hides, and the inventories at the end.

A summary of the appreciation or depreciation on each part of the enterprise is given in table 20.

Calves born during the year were charged to heifers, herd bulls, and veals and bulls to be sold, at their values at birth. They were credited to cows but were not included in the returns from cattle. The data are given in table 21.

Manure recovered

No credit was given for manure produced on pasture, and neither was the pasture charged with it. To have credited and charged manure in these different places would have increased the total costs and total returns for cattle by the same amount, without affecting the gain or loss on the enterprise or the cost of producing milk. The 149 farmers estimated that 20,642 tons of manure was recovered from cattle for use on crop land. This is 7.7 tons per cattle unit, there being 2670.3 cattle units.

The value of manure depends, not only on the composition of the ration, but also on the proportion and kind of litter and especially on the possible returns from its use. Estimates as to its value at the barn averaged about

TABLE 20. APPRECIATION AND DEPRECIATION ON CATTLE, 149 HERDS

	All herds		Cows			Heifers					
						Under 1 year			1 year or over		
	Total number	Total value	Number of farms	Number of cows	Value	Number of farms	Number of heifers	Value	Number of farms	Number of heifers	Value
On hand May 1, 1914	3,079 5	$156,153	149	2,029	$130,499	124	491	$6,636	109	389	$13,445
Purchased during year	284	12,445	47	134	8,620	20	53	474	13	32	1,358
Born during year						140	733	2,232			
Heifers that became cows	304	17,217	103	304	17,217						
Total		$185,815			$156,336			$9,342			$14,803
								($24,145)			
Slaughtered or sold for slaughter	1,193.5	$ 15,988	86	208	$ 8,009	2	2	$ 40	5	7	$ 239
Sold for breeding and production	374	8,800	42	117	6,370	61	188	910	7	13	372
Died or killed by accident	135		38	*55		25	54		5	6	
Hides sold	134.5	590	38	50	†430	15	31	32	5	7	37
Heifers that became cows	304	17,217							103	304	17,217
Deacon hides	158	169									
Dead calf hides	21	20									
On hand May 1, 1915	3,460	171,019	149	2,087	135,805	137	574	7,955	127	550	19,230
Total		$213,803			$150,614			$8,937			$37,095
Appreciation‡		$27,988						$21,887	($46,032)		
Depreciation					$5,722						

* Includes 4 killed on railroad and 2 killed by lightning.
† Includes $70 indemnity for 2 cows killed by lightning on one farm.
‡ The appreciation on cattle exceeds the difference between the appreciation on heifers, herd bulls, and veals and bulls to be sold, and the depreciation on cows, by $4608, because the value of calves at birth is considered a separate credit for cows but is charged to young cattle in calculating appreciation.

TABLE 20 (*concluded*)

	Herd bulls									Veals						Bull calves to be sold		
	Bull calves to be kept			1 to 2 years			Over 2 years			Calves fatted			Calves not fatted					
	Number of farms	Number of bulls	Value	Number of farms	Number of bulls	Value	Number of farms	Number of bulls	Value	Number of farms	Number of calves	Value	Number of farms	Number of calves	Value	Number of farms	Number of bull calves	Value
On hand May 1, 1914	55	62	$824	51	51.5	$1,726	40	41	$2,865	4	11	$88	....	....	....	5	5	$ 70
Purchased during year	24	24	752	19	20.5	719	‖11	10.5	458	....	..	.....	3	4	$ 6	3	6	58
Born during year	50	54	226	....	...	. .	...	....	.....	....	....	....	137	937	1,650	42	75	311
Heifers that became cows	. .	....	.....	....	....	.....	....	....	.....	...	....	.....	....	....	.....	...	....	....
Total	....	...	$1,802	....	....	$2,445	...	....	$3,323	...	....	$88	...	....	$1,656	...	....	$439
Slaughtered or sold for slaughter	2	2	$ 40	26	25.5	($7,570) $ 990	29	30	$1,697	94	368	($2,183) $3,889	97	546	$963	5	5	$121
Sold for breeding and production	....	....	.....	6	7	308	7	7	573	....	...	.....	....	....	.....	26	42	207
Died or killed by accident	2	2	....	1	1	....	....	....	.....	9	16	.....	...	....	....	1	1	....
Hides sold	3	3	11	4	3.5	28	....	....	.....	18	39	51	....	....	.....	1	1	1
Heifers that became cows	...	....	.....	....	....	.....	....	....	.....	....	...	.....	....	....	....	...	....	..
Deacon hides	....	....	.....	....	....	.....	....	....	.....	....	...	...	....	....	....	....	....	....
Dead calf hides	...	....	....	...	..	....	....	....	. .	...	..	...	....	...	.....	....	...	....
On hand May 1, 1915	66	72	1,323	61	68	2,599	§50	49	3,340	8	20	209	1	2	4	20	38	554
Total	....	....	$1,374	...	...	$3,925	....	....	$5,610	..	...	$4,149	...	....	$967	....	...	$943
Appreciation	....	...	$3,339	($10,909)		....	....	....	.....	....	...	($6,050)		$3,876	....	....	...	....
Depreciation	....	....	.....	....	....	.....	....	....	.....	...	....	....	....	....	....	..	...	...

‖ One farmer purchased half-interest in bull.
§ Two farmers owned half interest in bulls.

$1.25 a ton. This does not include the cost of hauling it to the field. Manure was credited to cattle on each farm at this rate. The credit was then apportioned to cows, to heifers, and to herd bulls, according to the average inventory of cattle units. No attempt was made to calculate

TABLE 21. NUMBER OF CALVES BORN DURING THE YEAR, AND VALUE AT BIRTH

	Number of farms	Number	Per cent	Value	Value of each at birth
Heifers to be raised or to be sold	140	733	37	$2,232	$3.05
Bulls to be kept	50	54	3	226	4.19
Bulls sold or to be sold	42	75	4	311	4.15
Calves vealed or to be vealed	137	937	48	1,650	1.76
Calves deaconed	51	162	8	......	....
Deacon hides	50	158	......	169	1.07
Total calves born alive	147	1,961	100	$4,588	$2.34
Live calves per 100 cows	......	95	......	......	....
Calves born dead	35	53	......	......	....
Dead calf hides	13	21	......	20	....
Total credited to cows	......	......	......	$4,608	....
Cows that aborted	25	41	......	......	....
Farrow cows	47	97	......	......	....

the value of manure on the basis of rations fed, for the reason that other factors have an equal, if not greater, influence. Neither was it considered practical to vary the credit to different classes of stock on the basis of the composition of the rations. The value of manure was $9.66 per cattle unit. This was 11.1 per cent of the total returns from cattle.

The data for manure recovered are given in table 22:

TABLE 22. MANURE RECOVERED FROM 2058 COWS, 1002 HEIFERS, 172 HERD BULLS, AND 76 BULLS TO BE SOLD

Manure recovered	All herds	Cows	Heifers	Herd bulls	Bulls to be sold
Tons	20,642	15,917	3,870	851	4
Value at $1.25 a ton at the barnyard	$25,802	$19,896.64	$4,837.65	$1,063.21	$4.50

Miscellaneous returns

Two farms received $157 for hauling neighbors' milk, three farms received $52 for boarding cattle, and fifteen farms received $142 for the use of herd bulls. These receipts were included under miscellaneous returns and represented 0.2 per cent of the total returns from the enterprise. The figures for miscellaneous returns are given in table 23:

TABLE 23. MISCELLANEOUS RETURNS

Item	Number of farms having receipt	Total amount received	Credited to	
			Cows	Herd bulls
Hauling neighbors' milk	2	$157	$157	....
Breeding fees	15	142	....	$142
Boarding cows	3	52	52	....
Total	....	$351	$209	$142

Summary of costs and returns

The separate items of costs and returns for the whole enterprise, and for cows, heifers, herd bulls, and veals and bulls to be sold, given in previous tables, are summarized in table 24.

Cost of producing milk and butterfat

In this investigation two different methods of calculating the cost of producing milk or butterfat were used.

By one method, considering the entire herd as a unit, all returns from the herd except milk sold were deducted from the total herd costs, and the difference was considered the cost of milk or fat sold. Any expense for raising young cattle to replace the herd was included in determining the cost of production. The cost calculated in this manner is designated thruout this bulletin as the " herd cost " of milk or butterfat.

By the second method, the returns from cows other than milk sold were deducted from the total cost of keeping cows to determine the cost of milk or fat. Bull service was charged at cost. The raising of heifers to replace the herd was considered separately, and any loss or gain on them was not charged nor credited to milk production. The cost determined in this manner is designated thruout this bulletin as the " cow cost " of producing milk or butterfat.

The herd cost and the cow cost of milk are practically identical. The herd cost is the simpler to calculate, because it is not necessary to separate the feed, labor, and other costs for heifers, bulls, and other cattle. But the quantities of feed and labor used by the herd per hundred pounds of milk are not so useful as the quantities used by cows only.

In purebred herds, the value of young stock for breeding purposes is sometimes so great as to make the herd cost of producing milk very low. The investment in cows, depreciation on cows, amount of feed and labor, bull service, and all other costs, are higher for purebred than for grade herds. But the greater value of the calves at birth usually more than offsets these higher costs, so that the cow cost of producing milk is also usually less in purebred than in grade herds.

	Table	All herds			Cows	
		Amount	Value	Per cent	Amount	Value
Costs:						
Grain	1	3,222,483 pounds	$48,219.00	20.1	2,895,814 pounds	$42,858.00
Succulent feeds (except skimmilk)	2	5,193.53 tons	24,609.00	10.2	4,777.33 tons	22,512.00
Dry forage	3	5,277.15 tons	50,790.00	21.1	4,283.05 tons	40,722.00
Skimmilk, purchased	2	21.8 tons	77.00	0.1		
Skimmilk, farm				*		
Whole milk, farm						
Buttermilk, farm						
Pasture	5	7,927.5 acres	11,591.00	4.8		9,338.00
Total feed			$135,286.00	56.3		$115,430.00
Bedding	6		2,080.00	0.9		1,673.00
Human labor	7	381,101 hours	54,767.65	22.8	345,370 hours	49,408.00
Horse labor	7	12,575 hours	1,886.25	0.8	11,279 hours	1,691.85
Hauling milk	8		19,684.79	8.2		19,684.79
Use of buildings	10		11,315.36	4.7		8,705.69
Use of equipment	12		1,308.20	0.5		1,015.10
Interest on cattle	13		8,155.45	3.4		6,657.40
Interest on feed and supplies for cattle	14		1,908.00	0.8		1,511.50
Breeding fees	15		183.00	0.1		183.00
Cost of keeping herd bulls	131					1,788.30
Depreciation on cows	20					5,722.00
Miscellaneous	15		3,713.00	1.5		3,496.00
Total costs			$240,287.70	100.0		$216,966.63
Returns:						
Other than milk sold:						
Milk products sold	18		$ 342.76	0.1		$ 342.76
Milk and its products used on the farm, except that fed cattle	18		7,309.00	3.1		7,309.00
Milk and its products fed cattle	18					7,265.01

* Fat calves sold, slaughtered, and on hand at end of year, less number on hand at beginning of year.

TABLE 24 (*continued*)

	Table	All herds			Cows	
		Amount	Value	Per cent	Amount	Value
Returns (*concluded*):						
Other than milk sold (*concluded*):						
Appreciation on cattle	20	....	$27,988.00	12.0	....	....
Calves and calf hides	21	....	....	......	....	$ 4,608.00
Manure	22	20,642 tons	25,802.00	11.1	15,917 tons	19,896.64
Miscellaneous	23	....	351.00	0.2	....	209.00
Total returns, excluding milk sold	......	....	$61,792.76	......	....	$39,630.41
Milk sold	17	10,473,226 pounds	$171,552.22	73.5	10,473,226 pounds	$171,552.22
Total returns	......	....	$233,344.98	100.0	....	$211,182.63
Profit or loss	......	....	−$6,942.72	......	....	−$5,784.00
Costs less returns other than milk sold (= cost of milk at market)	......	....	$178,494.94	......	....	$177,336.22
Cost per hundred pounds sold	......	....	$1.704	......	....	$1.693

TABLE 24 (*continued*)

	Table	Heifers		Herd bulls		Veals and bulls to be sold	
		Amount	Value	Amount	Value	Amount	Value
Costs:							
Grain	1	267,116 pounds	$4,390.00	58,203 pounds	$ 948.00	1,350 pounds	$ 23.00
Succulent feeds (except skimmilk)	2	335.35 tons	1,700.00	80.85 tons	397.00		
Dry forage	3	806.1 tons	8,146 00	187.1 tons	1,911.00	0.9 ton	11.00
Skimmilk, purchased	2	18.69 tons	64.00	1.39 tons	6.00	1.72 tons	7.00
Skimmilk, farm	18	96,068 pounds	171.17	6,493 pounds	11.08	3,072 pounds	6.16
Whole milk, farm	18	215,464 pounds	3,517.77	26,275 pounds	429.47	193,535 pounds	3,126.91
Buttermilk, farm	18	1,300 pounds	2.45				
Pasture	5		1,907.00		346.00		
Total feed			$19,898.39		$4,048.55		$3,174.07
Bedding	6		292.00		115.00		
Human labor	7	27,734 hours	4,160.10	7,997 hours	1,199 55		
Horse labor	7	1,259 hours	188.85	37 hours	5.55		
Hauling milk	8						
Use of buildings	10		2,143.21		464.46		2.00
Use of equipment	12		221.45		71 65		
Interest on cattle	13		1,181.30		316.75		
Interest on feed and supplies for cattle	14		305.50		91.00		
Breeding fees	15						
Cost of keeping herd bulls	131						
Depreciation on cows	20						
Miscellaneous	15		182.00		20 00		15.00
Total costs			$28,572.80		$6,332.51		$3,191.07
Returns:							
Other than milk sold:							
Milk products sold	18						
Milk and its products used on the farm, except that fed cattle	18						

TABLE 24 (*concluded*)

	Table	Heifers		Herd bulls		Veals and bulls to be sold	
		Amount	Value	Amount	Value	Amount	Value
Returns (*concluded*):							
Other than milk sold (*concl'd*):							
Milk and its products fed cattle	18	...	...	...	...	...	...
Appreciation on cattle	20	...	$21,887.00	...	$3,339.00	...	$3,876.00
Calves and calf hides	21	...	...	...	...	...	...
Manure	22	3,870 tons	4,837.65	851 tons	1,063.21	4 tons	4.50
Miscellaneous	23	...	...	...	142.00	...	...
Total returns, excluding milk sold	...	...	...	...	...	...	...
Milk sold	17	...	...	...	...	...	...
Total returns	...	...	$26,724.65	...	$4,544.21	...	$3,880.50
Profit or loss	...	...	−$1,848.15	...	†−$1,788.30	...	+$689.43
Costs less returns other than milk sold (= cost of milk at market)	...	...	...	...	...	...	...
Cost per hundred pounds sold	...	...	...	...	...	...	...

† Charged to cows.

The cost includes delivering to the receiving stations. Prices are paid for milk delivered. In order to be comparable the cost of production on different farms should therefore include the cost of delivery.

A comparison of the herd cost and the cow cost of producing milk and butterfat is given in table 25:

TABLE 25. SUMMARY OF COST OF PRODUCING AND DELIVERING TO MARKET 104,732 HUNDREDWEIGHT OF MILK CONTAINING 420,673 POUNDS OF BUTTERFAT

	Herd cost			Cow cost		
	(2058 cows, 1002 heifers, 172 herd bulls, 377 veals, and 76 bulls to be sold)			(2058 cows)		
	Per hundred pounds of milk sold	Per cent	Per pound of butterfat	Per hundred pounds of milk sold	Per cent	Per pound of butterfat
Costs:						
Grain	$0 460	20.1	$0.1146	$0.409	20.2	$0.1019
Succulent feed	0.236	10.3	0.0587	0.215	10.6	0.0535
Dry forage	0 485	21.1	0.1207	0.389	19.2	0.0968
Pasture	0.111	4.8	0.0276	0.089	4.4	0.0222
Total feed	$1.292	56.3	$0.3216	$1.102	54.4	$0.2744
Bedding	0.020	0.9	0.0049	0.016	0.8	0.0040
Human labor	0.523	22.8	0.1302	0.472	23.3	0.1174
Horse labor	0.018	0.8	0.0045	0.016	0.8	0.0040
Hauling milk	0.188	8.2	0.0468	0.188	9.3	0.0468
Use of buildings	0.108	4.7	0.0269	0.083	4.1	0.0207
Use of equipment	0.012	0.5	0.0031	0.010	0.5	0.0024
Interest on cattle	0.078	3.4	0.0194	0.064	3.1	0.0158
Interest on feed and supplies	0.018	0.8	0.0045	0.014	0.7	0.0036
Breeding fees	0.002	0.1	0.0004	0.002	0.1	0.0004
Cost of keeping herd bulls	....	......	....	0.017	0.8	0.0043
Depreciation on cows	....	......	....	0.055	0.5	0.0136
Miscellaneous	0.035	1.5	0.0088	0.033	1.6	0.0083
Total costs	$2.294	100.0	$0.5711	$2.072	100.0	$0.5157
Returns other than milk sold:						
Milk products sold	$0.003	......	$0.0008	$0.003	......	$0.0008
Milk and its products used on farm, except that fed cattle	0.070	......	0.0174	0.070	......	0.0174
Milk and its products fed cattle	....	......	....	0.070	......	0.0173
Appreciation on cattle	0.267	......	0.0665	....	......	....
Calves and calf hides	....	......	....	0.044	......	0.0109
Manure	0.247	......	0.0613	0.190	......	0.0473
Miscellaneous	0.003	......	0.0008	0.002	......	0.0005
Total returns, other than milk sold	$0.590	......	$0.1468	$0.379	......	$0.0942
Cost of milk or butterfat at market	$1.704	......	$0.4243	$1.693	......	$0.4215

The gross herd charges per hundred pounds of milk sold were $2.29, but the returns other than milk sold amounted to 59 cents per hundred pounds. The herd cost of milk, therefore, was $1.70 per hundred pounds sold.

The gross cow charges were $2.07 per hundred pounds, and the returns other than milk sold were 38 cents. Hence, the cow cost of milk was $1.69 per hundred pounds sold.

The herd cost and the cow cost were practically the same, the former being 1.1 cents per hundred pounds higher. In other words, the loss on heifers, above the gain on veals and bulls to be sold, increased the cost of milk production only by this amount.

The gross herd charges were 57.1 cents per pound of butterfat sold. The returns other than for milk sold were 14.7 cents, so that the net herd cost per pound of butterfat was 42.4 cents.

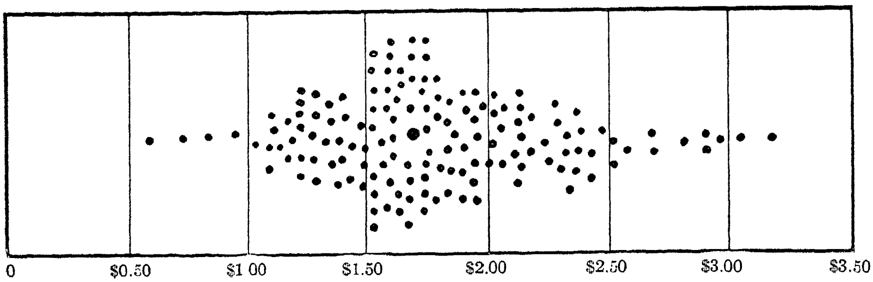

FIG. 53. VARIATION IN HERD COST OF PRODUCING MILK, 149 FARMS

The cow charges were 51.6 cents per pound of butterfat. The returns, except for milk sold, were 9.4 cents, making the net cow cost per pound of butterfat sold 42.2 cents.

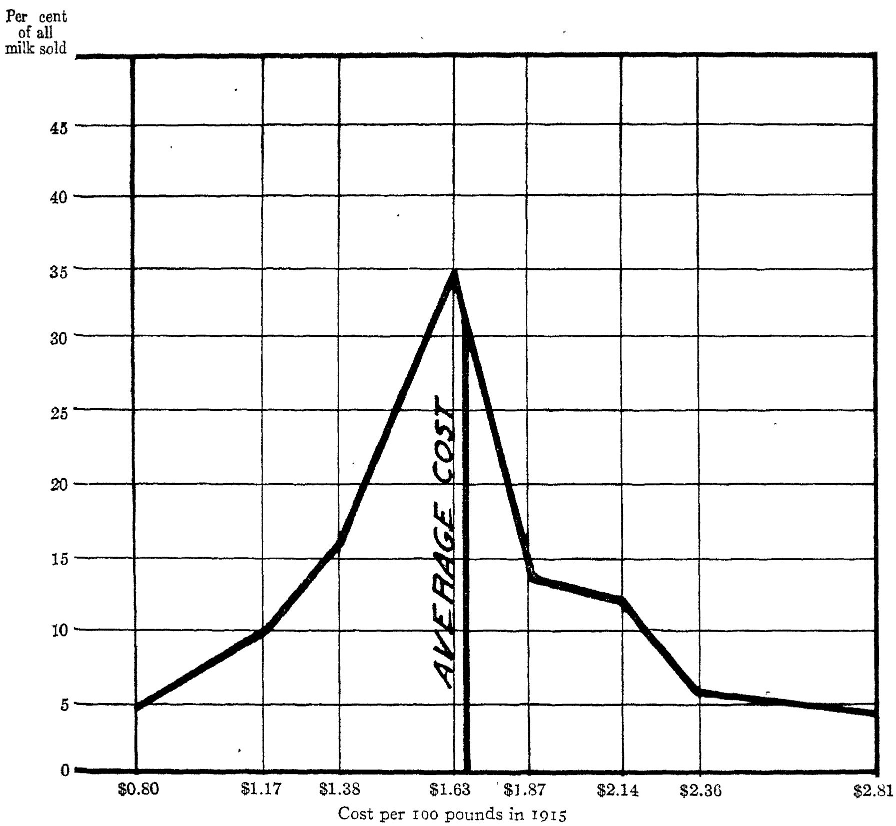

FIG. 54. VARIATION IN HERD COST OF PRODUCING MILK, 149 FARMS

TABLE 26. VARIATIONS IN THE HERD COST OF PRODUCING MILK ON 149 FARMS

Herd cost of milk per hundredweight	Number of farms	Per cent of number of farms	Average cost per hundred-weight	Number of cows	Per cent of number of cows	Hundred-weight of milk sold	Per cent of all milk sold by each group	Cumu-lative per cent of milk sold	Hundred-weight of milk sold, November to April	Per cent of all milk sold, November to April	Per cent of group milk sold, November to April
Under $1.00	4	2.7	$0.80	72.5	3.5	3,902	3.7	3.7	1,334	2.9	34.2
$1.00–$1.25	15	10.1	1.17	195.5	9.5	10,131	9.7	13.4	4,175	9.2	41.2
1.26– 1.50	20	13.4	1.38	311.5	15.1	17,026	16.3	29.7	7,127	15.7	41.9
1.51– 1.75	45	30.2	1.63	696.5	33.9	36,735	35.1	64.8	15,586	34.4	42.4
1.76– 2.00	24	16.1	1.87	270.0	13.1	13,481	12.9	77.7	6,005	13.3	44.5
2.01– 2.25	17	11.4	2.14	245.5	11.9	12,200	11.6	89.3	5,913	13.0	48.5
2.26– 2.50	13	8.7	2.36	144.0	7.0	6,428	6.1	95 4	3,142	6.9	48.9
Over $2.50	11	7.4	2.81	122.5	6.0	4,829	4.6	100.0	2,097	4.6	43.4

When the calculations were based on the total amount of milk or butterfat produced, the cow cost of production was practically the same as when the milk or fat sold was used. The cow cost per hundred pounds of milk produced was $1.689, and the cost per hundred pounds sold was $1.693. The cow cost of fat was 42 cents per pound produced, or 42.2 cents per pound sold.

The lowest herd cost of milk production was 56 cents per hundred pounds. To increased value on purebred cows and higher values of the calves at birth this low cost was due. The highest cost was $3.19 per hundred pounds. Of the farms studied, 48 per cent produced milk at less than the average cost, but 54 per cent of the milk was produced at less than the average cost. The more efficient farms produce a larger proportion of the product. The average cost of all milk produced below the average cost was $1.39 per hundred pounds, and of all milk at the average cost or above, $2.06 per hundred pounds.

Variations in the herd cost of producing milk on these farms are shown in table 26 and in figures 53 and 54.

Quantities of feed and labor per unit of product

The amounts of feed and labor used by all herds, per hundred pounds of milk produced, per hundred pounds produced except that fed cattle, and per hundred pounds sold, are given in table 27:

TABLE 27. AMOUNTS OF FEED AND LABOR USED BY 2058 COWS, 1002 HEIFERS, 172 HERD BULLS, AND 76 BULLS TO BE SOLD, PER HUNDRED POUNDS OF MILK

	Per 100 pounds of milk		
	Produced	Produced, except that fed cattle	Sold
	Pounds		
Grain	28.3	29.7	30.8
Succulent feed	91.6	96.1	99.6
Dry forage	92.7	97.3	100.8
	Hours		
Human labor:			
Hauling milk	0.35	0.37	0.39
Other labor	3.35	3.51	3.64
Horse labor:			
Hauling milk	0.51	0.54	0.56
Other labor	0.11	0.12	0.12

Capital invested for milk production

The average investment for milk production was $3381 per farm, $244.78 per cow, and $4.42 per hundred pounds of milk or $1.10 per pound of

butterfat produced. These values would have been higher in 1920, due to a higher price level for all commodities. The data are given in table 28:

TABLE 28. CAPITAL INVESTED FOR THE PRODUCTION OF 11,385,590 POUNDS OF MILK CONTAINING 457,223 POUNDS OF BUTTERFAT, 149 HERDS

	Total capital	Per cent	Per farm	Per cow	Per 100 pounds of milk produced	Per pound of butterfat produced
Cows	$133,148	26.4	$ 894	$64.70	$1.17	$0.29
Herd bulls	6,335	1.3	42	3.08	0.05	0.01
Other cattle	23,626	4.7	159	11.48	0.21	0.05
Buildings	145,714	28.9	978	70.80	1.28	0.32
Equipment	5,398	1.1	36	2.62	0.05	0.01
Pasture land	151,376	30.0	1,016	73.56	1.33	0.33
Feed and supplies	38,160	7.6	256	18.54	0.33	0.09
Total	$503,757	100.0	$3,381	$244.78	$4.42	$1.10
Interest at 5 per cent	$25,188	......	$169	$12.24	$0.221	$0.055

Effect of changes in the price of labor, of feed, and of other factors, on the cost of milk production

The cost of producing milk for any particular farm or for any region is not constant. Whenever the price of cows, the price of feed, the value of land, or wages, change, then the cost of milk production also changes. Hence, when interpreting results of milk-production studies, it is important to keep in mind the possible effect of such changes on cost.

In table 29 are shown the approximate changes in cost made by the change of a single item, provided all other costs remain constant. An increase in any item, however, is accompained by changes in practically all other items. For example, if any cost increases, the cost of cows, and

TABLE 29. EFFECT OF CHANGES IN PRICES OF LABOR, FEED, AND OTHER FACTORS, ON COST OF PRODUCTION WHEN THE ENTIRE HERD IS CONSIDERED

If other conditions remained exactly the same, a change of:	Would change on these farms	
	The cost of producing 100 pounds of milk	The cost of producing 1 pound of butterfat
	Cents	Cents
1 per cent in the interest rate	4.4	1.1
$10 an acre in the value of pasture land	3.3	0.8
1 cent an hour of human labor	3.8	0.9
$1 a ton for grain	1.4	0.4
$1 a ton for succulent feed	4.6	1.1
$1 a ton for dry forage	4.6	1.2

hence depreciation and interest on them, also increases. If wages increase, the cost of pasture and buildings goes up. Moreover, a change in the cost of feed, cows, or labor causes dairymen to modify their practices. For all these reasons, one can never safely predict what will be the effect of a change in any one item on the cost of production as a whole.

PART II. CONCERNING COWS

Breeds

Practically all of the dairy herds in Broome County are of grade stock, but most of the cattle carry some Holstein blood. Probably animals of this breed are best adapted to the production of market milk under the prevailing conditions of the region, chiefly because of their large size.

About two per cent of the dairy cattle in the county are purebred. In January, 1917, there were 498 purebred Holsteins on 45 farms, 53 purebred Jerseys on 7 farms, 40 purebred Ayrshires on 2 farms, and 20 purebred Guernseys on 6 farms, in Broome County. On 31 of the farms there were less than 6 head of purebred dairy cattle, and on only 8 of the 149 farms were there as many as 20 purebreds.

On the farms included in this study there were only 39 registered cows. Excepting one Ayrshire and one Dutch Belted, these were all Holsteins. Records for two purebred Holstein herds containing 52 cows were obtained, but were not included in the tabulations. The market for purebred dairy cattle in the southern-tier counties is relatively undeveloped. It is no doubt due largely to this fact, and to the more extensive system of dairying, that few purebred animals have been brought into the county.

Owing to the fact that the herds were so largely of Holstein characteristics, it was impossible to group them in any manner that would allow a comparison of one breed with another. There were six herds of purebred Holstein and Holstein grades, twenty-eight high-grade Holstein herds, twenty-eight herds comprised of Holstein grades and animals of mixed breeding, eleven herds of part Holstein grades and part Jersey grades, six herds of part Holstein grades and part Guernsey grades, and seventy herds of various other combinations of breeding. Most of the larger herds are Holstein grades, while more of the smaller herds are of mixed breeding.

Numbers

The inventories, purchases, sales, and deaths of cows are given in detail in table 20 (page 301). The average number of cows was 2058, and the average value was $65 a head. The number per farm varied from 6 to 37, the average being 13.8.

During the year 47 farms purchased 134 cows at an average price of $64 a head. On 103 farms there were 304 heifers that freshened for the

first time during the year. The average value at the time of freshening was $57 a head. About one cow was purchased or raised for each five kept. But as the herds are increasing in size, and as some cows are sold for production, only one cow of each seven or eight is actually replaced each year. The estimates of 131 dairymen as to the time cows remained in the herd after first freshening averaged 7.5 years.

Of the cows disposed of, 208 were slaughtered or sold for slaughter on 86 farms, and 117 were sold for breeding and production on 42 farms. The average price received for the former was $38, for the latter $54, a head.

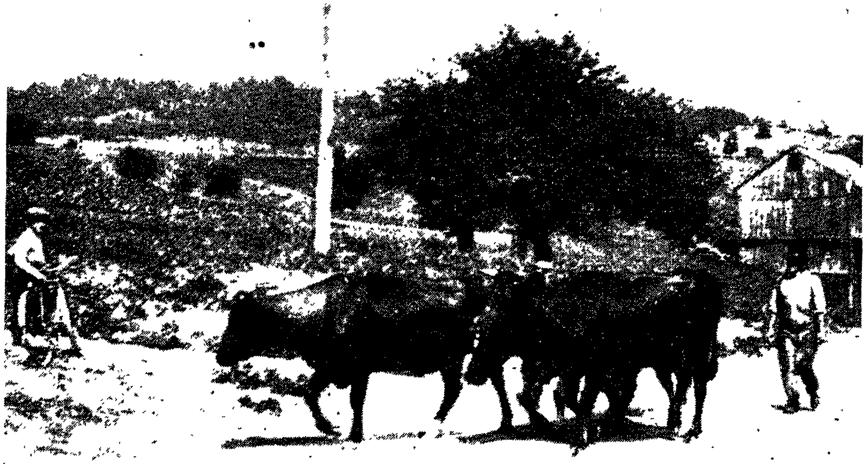

FIG. 55. GOING TO THE BUTCHER

The figures indicate that about two-thirds of the cows disposed of are slaughtered or sold for slaughter, and that the remaining third go into other herds to be milked. But farmers do not know exactly where the cows they sell go. The relatively low price of those sold for production suggests that probably some that went to the block have been included in this group.

During the year 38 farms lost 55 cows by death or accident. Of these cows, 49 died, 4 were killed on the railroad, and 2 were killed by lightning. This is 2.7 per cent of the average number of cows. Receipts from the sales of hides and insurance for cows killed amounted to $7.82 per cow lost.

The average price of all cows slaughtered and sold was $44 a head. This is $21 a head less than the average value of cows. The depreciation

on cows and the loss due to death was $5722, or 4.3 per cent of the average value of cows. About two-thirds of this loss is represented by the difference between the value of cows and the price received for those sold, and one-third by deaths. Since the beef value of cows is not in proportion to their value for milk, depreciation and losses due to death are higher with higher-priced cows.

Average production

The average production per cow was 5532 pounds of milk, of which 5089 pounds was sold and 443 pounds was used on the farms, and 222.2 pounds of butterfat, of which 204.4 pounds was sold. About 42 per cent of the milk was produced in the six months beginning on October 1, and 58 per cent in the summer months from April to September.

The income from the sale of milk was more evenly distributed thruout the year than was the production. While more milk was sold in summer, the price received was so much less that the returns did not far exceed the returns in the winter months.

The data on average production are given in table 30:

TABLE 30. PRODUCTION PER COW AND ITS DISTRIBUTION, 2058 COWS

	Number of pounds of milk per cow	Per cent of total yearly production	Number of pounds of butterfat per cow	Receipts per cow from milk sold	Per cent of total receipts
Milk sold:					
May	614	12.1	24.0	$7.86	9.4
June	621	12.2	24.2	7.50	9.0
July	501	9.8	20.0	6.82	8.2
August	391	7.7	16.0	6.06	7.3
September	355	7.0	14.9	5.99	7.2
October	368	7.2	15.5	7.22	8.7
November	330	6.5	13.8	6.78	8.1
December	345	6.8	14.5	7.13	8.6
January	358	7.0	14.3	7.14	8.6
February	328	6.4	12.8	6.17	7.4
March	395	7.8	15.4	7.13	8.5
April	449	8.8	17.5	6.77	8.1
Retail	34	0.7	1.5	0.79	0.9
Total	5,089	100.0	204.4	$83.36	100.0
Milk not sold	443	....	17.8	7.25	....
Total	5,532	....	222.2	$90.61	....

Relative to the receipts on the New York market, much more milk was produced during the summer on the farms studied. The production in February, the lowest month, was 53 per cent of the June production, while on the New York market for the same year the amount received in February was 92 per cent of the amount received in June.

Less milk is furnished the city during July, August, or September than during January by the zones nearer the city.[7] These zones are the districts of most intensive dairying. The supply from the further zones, however, is much greater during the summer months. Prices paid for milk to be

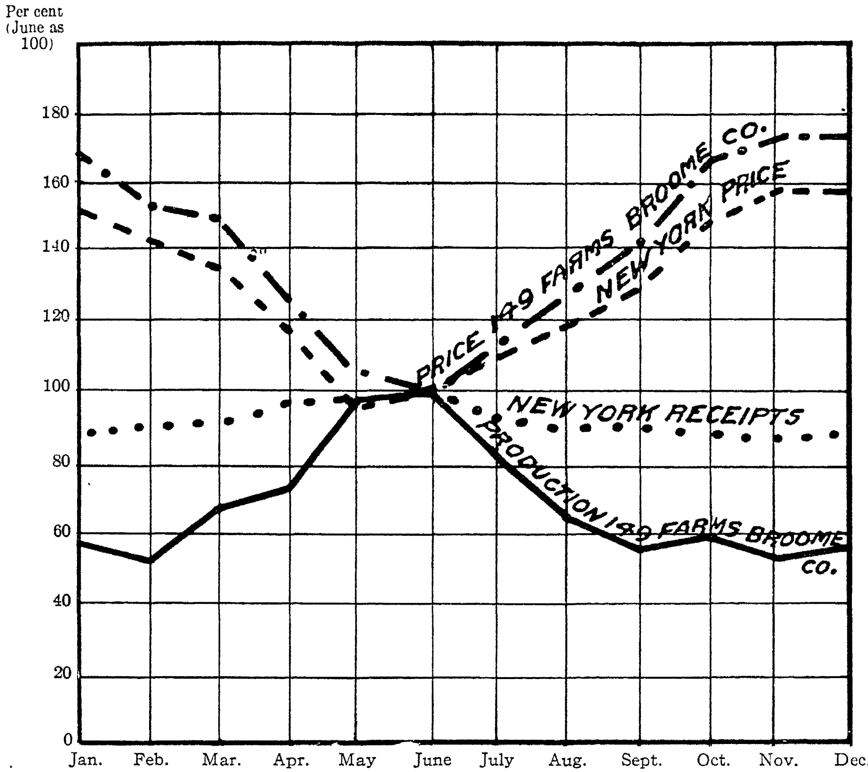

FIG. 56. PRODUCTION AND PRICE FOR 149 BROOME COUNTY FARMS COMPARED WITH RECEIPTS ON, AND WITH AVERAGE PRICES PAID AT SHIPPING STATIONS TO PRODUCERS FOR, THE NEW YORK MARKET

shipped to cities during these months must be in close accord with the prices that can be obtained from milk by making it into butter, cheese, or condensed milk, else milk will be attracted to the shipping stations from the factories and too great a surplus results. Production on these Broome County farms is more typical of the far zones than of the districts nearer the city.

[7] Preliminary Report of the Joint Legislative Committee on Dairy Products, Livestock, and Poultry. New York Senate Document, no. 35, page 340.

The figures for distribution are given in table 31:

TABLE 31. DISTRIBUTION OF PRODUCTION, AND PRICES RECEIVED FOR MILK, ON 149 BROOME COUNTY FARMS, COMPARED WITH DISTRIBUTION OF RECEIPTS IN THE NEW YORK MARKET AND WITH AVERAGE PRICES PAID AT SHIPPING STATIONS TO PRODUCERS OF MILK FOR NEW YORK CITY, IN THE SAME YEAR

Month	Daily average receipts on New York market, 40-quart cans	Per cent (June figure taken as 100)	Milk sold by 149 farms (hundred-weight)	Per cent (June figure taken as 100)	Average prices paid producers for New York market*	Average prices received by 149 farms
1914:						
May	53,450	98	12,635	99	$1.25	$1.28
June	54,807	100	12,779	100	1.29	1.21
July	51,454	94	10,312	81	1.41	1.36
August	50,058	91	8,045	63	1.53	1.55
September	49,831	91	7,294	57	1.64	1.69
October	48,641	89	7,579	59	1.76	1.96
November	47,852	87	6,783	53	2.00	2.06
December	48,411	88	7,108	56	2.00	2.06
1915:						
January	48,332	88	7,359	58	1.94	2.00
February	50,529	92	6,748	53	1.85	1.88
March	50,996	93	8,138	64	1.76	1.80
April	52,419	96	9,243	72	1.53	1.51

*As given in *The Milk Reporter*, Sussex, New Jersey, for the respective months.

Feeds used

The total amounts and values of the various kinds of feed used by cows are given in previous tables. The amounts per cow, per hundred pounds of milk produced, and per pound of butterfat produced, are shown in table 32:

TABLE 32. FEED USED BY 2058 COWS

	From table	Total	Pounds used		
			Per cow	Per 100 pounds of milk produced	Per pound of butterfat produced
Grain	1	2,895,814 pounds	1,407	25.4	6.3
Silage	2	3,915.9 tons	3,806	68.8	17.1
Other succulent feed	2	861.43 tons	837	15.1	3.8
Hay	3	3,553.45 tons	3,453	62.4	15.5
Other dry forage	3	729.60 tons	709	12.8	3.2

An average of about 4 pounds of milk, containing 4 per cent of butterfat, was produced per pound of grain fed. The quantities of feed used on these farms per pound of butterfat produced, check closely with the quantities used in experiment station herds, as shown in table 33. The

TABLE 33. FEED USED AND PRODUCTION PER COW IN EXPERIMENT STATION HERDS

Station	Number of years covered by record	Number of records	Pounds of milk	Butterfat test of milk (per cent)	Pounds of fat	Pounds of concentrates	Pounds of silage	Pounds of other succulent feed	Pounds of hay	Pounds of other dry forage
Connecticut [a]	10	227	5,947	4.67	278	2,277	8,535	176	1,859	38
Massachusetts [b]	15	131	6,036	5.07	306	2,155	1,820	3,118	4,820	278
Michigan [c]	1	29	6,610	3.71	245	2,774	3,649	1,990	3,252	734
Minnesota [d]	1	23	6,408	4.70	301	3,474	3,479	1,827	2,029	.....
Missouri [e]	1	12	5,927	4.18	248	3,027	.....	.....	3,480	.....
Montana [f]	1	15	5,992	4.17	250	1,169	.....	.....	6,468	.....
Nebraska [g]	2	52	8,796	3.87	340	1,981	3,684	.....	2,343	.....
New Jersey [h]	14	415	6,792	4.16	283	2,721	8,008	8,076	1,383	679
Utah [i]	5	49	5,601	4.23	237	1,305	.....	.....	4,518	.....
Wisconsin [j]	12	261	7,540	4.28	322	2,014	7,549	1,648	1,356	.....
Total	....	1,214	....	....	....	.....	.....	.....	.....	.....
Simple averages:										
Per cow	....	....	6,565	4.30	281	2,290	3,672	1,684	3,151	173
Per 100 pounds of milk	....	....	....	....	....	34.9	55.9	25.7	48.0	2.6
Per pound of butterfat	....	....	....	....	....	8.1	13.1	6.0	11.2	0.6

[a] Bulletins 29, 73. [b] Bulletin 145. [c] Bulletin 166. [d] Bulletin 35. [e] Bulletin 26. [f] Report 1905. [g] Bulletin 101. [h] Reports 1897–1906, 1909, 1912–1915. [i] Bulletin 68. [j] Reports 1905–1907; Bulletins 102, 187, 217.

station herds used more grain but less dry forage. Since grain contains from two to two and one-half times as much energy as does hay, the extra grain used compensates for the smaller amount of dry forage, especially if one allows for the use of a better grade of hay at the stations. No account could be taken of pasture, as it was reported in days but not in acres used. At the New Jersey and Massachusetts stations, very little pasture was used. These stations depended largely on soiling crops for summer feeding.

Labor required

An average per cow of 90.1 hours of human labor was spent in milking, 19.6 hours in hauling the milk, and 77.7 hours in other work. This is a total of 187.4 hours per cow, 3.38 hours per hundred pounds of milk produced, and 0.85 hour per pound of butterfat produced.

Most of the horse labor was in hauling the milk. This amounted to 28.4 hours out of a total of 33.9 hours per cow.

The data on labor required are given in table 34:

TABLE 34. LABOR REQUIRED FOR 2058 COWS

	Hours per cow*	Hours per 100 pounds of milk produced	Hours per pound of butterfat produced
Human labor:			
Milking:			
Man	76.2	1.38	0.34
Woman	8.0	0.14	0.04
Child	5.9	0.11	0.03
Total	90.1	1.63	0.41
Care of cows, product, and utensils:			
Man	64.9	1.17	0.30
Woman	7.0	0.13	0.03
Child	2.4	0.04	0.01
Hauling feed	2.0	0.04	0.01
Other human labor	1.4	0.02	0.00
Total	167.8	3.03	0.76
Hauling milk	19.6	0.35	0.09
Total human labor	187.4	3.38	0.85
Horse labor:			
Hauling milk	28.4	0.51	0.13
Other horse labor	5.5	0.10	0.02
Total horse labor	33.9	0.61	0.15

* Totals are given in table 7 (page 288).

Costs and returns

The total costs per cow were $105.43. Of this, 53.2 per cent was for feed including pasture, 22.8 per cent was for human labor except milk

hauling, and 24 per cent was for the remaining items. The total returns per cow were $102.62, of which 81.2 per cent was for milk sold, 9.4 per cent was for manure, and 9.4 per cent was for other items. The average loss on cows was $2.81 per cow. (Table 35.) Of the 149 herds, there were 61, or 41 per cent, that showed a profit on cows.

A common question that arises whenever results of cost studies are stated, is, if the actual loss is equal to the apparent loss, how do such producers remain in business? The answer is that they do one or more of the following things: first, accept lower wages than the rate at which their time is charged; secondly, accept less than farm value for roughage used; thirdly, accept a lower rate of interest on their investment than the rate charged.

If these farmers received interest on their investment, the farm value of farm-grown roughage, and all other costs, they then received 11.3 cents an hour for human labor.

TABLE 35. AVERAGE COSTS AND RETURNS, 2058 COWS*

Item	Per cow	Per cent of total
Costs:		
Grain	$20.83	19.7
Succulent feed	10.94	10.4
Dry forage	19.79	18.8
Pasture	4.54	4.3
Total feed	$56.10	53.2
Bedding	0.81	0.8
Human labor	24.01	22.8
Horse labor	0.82	0.8
Hauling milk	9.57	9.1
Use of buildings	4.23	4.0
Use of equipment	0.49	0.4
Interest on cows	3.23	3.1
Interest on feed and supplies	0.73	0.7
Depreciation on cows	2.78	2.6
Bull service	0.96	0.9
Miscellaneous	1.70	1.6
Total costs	$105.43	100.0
Returns:		
Milk sold	$83.36	81.2
Milk products sold	0.17	0.2
Milk and its products used	7.08	6.9
Calves and calf hides	2.24	2.2
Manure	9.67	9.4
Miscellaneous	0.10	0.1
Total returns	$102.62	100.0
Loss	$2.81	....

* Totals are given in table 24 (pages 305 to 308).

If they received 15 cents an hour for all man time and 10 cents an hour for all time of women and children, and interest on their investment, they then received 90 per cent of the value of hay and other roughage used.

If it be assumed that the cost of feed and human labor represents the same proportion of the net cost of producing milk when feed and labor costs are high as when they are low, and that the quantities found in this study are used in the production of milk, then the yearly cost for 1920 price conditions may be computed as shown in table 36. The cost with the prices used would be $3.47 per hundred pounds. The index number of the prices of all commodities in the United States for the year 1920 was 243, as compared with 99 for the twelve months covered by this investigation.[8] The average price paid in 1920 to producers of milk for the New York market was $3.56 per hundred pounds.[9] Considering that the general price level stood at 245 as compared with that of 1914–15, this price of $3.56 in 1920 was about equal to a price of $1.45 in the years covered by this study. A cost of $3.47 would be approximately no greater when compared with the general price level than a cost of $1.42 in 1914–15. In the spring months of March, April, and May, 1920, the price of milk was low relative to feed and labor costs, but considering the year as a whole, it would appear that prices paid to shippers of fluid milk for the New York market were fairly well adjusted to cost of production.

The figures for costs and returns are given in table 35, and the probable cost in 1920 of keeping a cow and producing milk is shown in table 36.

TABLE 36. PROBABLE COST IN 1920 OF PRODUCING MILK

	Per cow			Per 100 pounds of milk	
	Amount used by 2058 cows in 1914–15	Estimated price in 1920	Cost at estimated 1920 prices	Amount used by 2058 cows in 1914–15	Cost at estimated 1920 prices
Grain	1,407 pounds	$60.00	$42.21	25.4 pounds	$0.762
Silage	3,806 pounds	7.00	13.32	68.8 pounds	0.241
Other succulent feed	837 pounds	5.00	2.09	15.1 pounds	0.038
Hay	3,453 pounds	20.00	34.53	62.4 pounds	0.624
Other dry forage	709 pounds	10.00	3.54	12.8 pounds	0.064
Human labor	187.4 hours	0.35	65.59	3.38 hours	1.183
Total feed and human labor	....	....	$161.28	....	$2.912
Per cent of net cost, 83.9					
Total cost assuming that feed and labor represent the same per cent of the net cost as in 1914–15	....	....	$192.23	....	$3.471

Size of herd

Of the herds on the farms studied, 36 per cent had from six to ten cows, 26 per cent had more than ten but not more than fourteen cows, 18

[8] United States Bureau of Labor Statistics. Monthly Review, vol. 12, no. 5, May, 1921.
[9] *The Milk Reporter*, Sussex, New Jersey, January, 1921, page 16.

per cent had more than fourteen but not more than eighteen cows, and 20 per cent had more than eighteen cows.

Size of farm

The size of the dairy is governed largely by the size of the farm. Farms keeping from six to ten cows averaged 111 acres, those with more than ten but not more than fourteen cows averaged 145 acres, those with more than fourteen but not more than eighteen cows averaged 177 acres, and those with more than eighteen cows averaged 238 acres.

The average distance to the milk station is less from farms with large herds than from farms with small herds. This is explained by the fact that a greater proportion of the large herds are in the valleys. The combined effect of a large load and a shorter haul considerably reduced marketing charges for the larger herds.

Feed used

Larger herds used more grain and more succulent feed per cow, but less dry forage, than did smaller herds. Production was better, and more of the milk was made, in winter. In other words, a more intensive system was followed. This is to be expected since many of these farms are nearer

TABLE 37. RELATION OF SIZE OF HERD TO VARIOUS FACTORS

	Number of cows per farm			
	6 to 10	10+ to 14	14+ to 18	Over 18
Number of farms	54	39	27	29
Acres per farm	111	145	177	238
Miles to market	3.7	3.8	2.5	3.1
Number of farms on hills	33	31	19	16
Number of farms in valleys	21	8	8	13
Per cent of farms on hills	61	79	70	55
Number of cows	461	485	436	676
Cows per farm	8.6	12.4	16.1	23.3
Number of cattle units	612.9	623.0	569.1	865.3
Acres per cattle unit	9.7	9.1	8.4	8.0
Cattle units per farm	11.4	16.0	21.1	29.8
Number using purebred bulls	9	8	7	15
Per cent using purebred bulls	17	20	25	52
Per cent of milk produced in six months, October to March	40	40	40	45
Pounds of milk per cow	5,461	5,323	5,344	5,853
Test of milk	4.1	4.0	4.0	4.0
Pounds of butterfat per cow	223	213	216	233
Pounds of grain per cow	1,313	1,343	1,448	1,484
Pounds of silage per cow	2,549	3,822	1,712	6,001
Pounds of other succulent feed per cow	811	837	633	988
Pounds of dry forage per cow	4,534	4,225	4,777	3,468
Number of farms feeding silage	18	22	9	20
Per cent feeding silage	33	56	33	69

TABLE 40. RELATION OF SIZE OF HERD TO COSTS AND RETURNS

	Number of cows per farm

TABLE 38. RELATION OF SIZE OF HERD TO LABOR USED PER COW AND PER UNIT OF PRODUCT

	Number of cows per farm											
	6 to 10			10+ to 14			14+ to 18			Over 18		
	Total hours	Hours per cow	Hours per 100 pounds of milk produced	Total hours	Hours per cow	Hours per 100 pounds of milk produced	Total hours	Hours per cow	Hours per 100 pounds of milk produced	Total hours	Hours per cow	Hours per 100 pounds of milk produced
Milking	46,768	101.5	1.86	45,981	94.8	1.78	36,326	83.3	1.56	56,279	83 3	1 42
Other chores	42,970	93.2	1.70	38,762	79.9	1.50	32,361	74.2	1.39	41,874	61.9	1 06
Hauling feed	925	2.0	0.04	1,230	2.6	0.05	602	1.4	0.02	1,292	1.9	0 03
Total	90,663	196.7	3.60	85,973	177.3	3.33	69,289	158.9	2 97	99,445	147 1	2 51
Hauling milk	9,371	20.3	0.37	10,377	21.4	0 40	11,125	25.5	0.48	9,464	14.0	0.24
Total	100,034	217.0	3.97	96,350	198.7	3.73	80,414	184.4	3.45	108,909	161.1	2.75

the market and on land that is better adapted to raising good winter feed. Some of the better production in the large herds may be due to the use of silage and to better feeding generally.

Data showing the relation of the size of herd to various other factors are given in table 37.

Labor required

The most important influence of size of herd is on labor per cow and per unit of product. The higher farm wages are, the more important this influence becomes.

In herds of from six to ten cows, averaging 8.6 cows, the labor averaged 217 hours per cow and 3.97 hours per hundred pounds of milk. Less labor was required in each of the groups of larger herds. In herds with more than eighteen cows, averaging 23.3 cows, the figures were 161 hours per cow and 2.75 hours per hundred pounds of milk. The data are given in table 38.

At 15 cents an hour the labor charges per hundred pounds of milk would be 19 cents more for 9-cow herds than for 23-cow herds. At 30 cents an hour they would be 37 cents more, and at 40 cents per hour they would be 49 cents more, per hundred pounds. The figures are given in table 39:

TABLE 39. Relation of Size of Herd to Labor Charge per Unit of Product

Number of cows per farm	Hours per cow*	Hours per 100 pounds of milk produced*	Labor charges at various rates per hour			
			15 cents	20 cents	30 cents	40 cents
8.6	217	3.97	$0.60	$0.79	$1.19	$1.59
12.4	199	3.73	0.56	0.75	1.12	1.49
16.1	184	3.45	0.52	0.69	1.04	1.38
23.3	161	2.75	0.41	0.55	0.82	1.10
Difference between 9- and 23-cow herds			$0.19	$0.24	$0.37	$0.49

* Including time for hauling milk.

Use of buildings

Much time is often wasted in doing chores in unhandy barns. The inconvenient location of milk house, ice house, or silo increases labor. Barns with cows facing outward so that a wagon, a sled, or a spreader may be driven thru for the manure, save labor, especially if the manure is hauled daily. Such an arrangement is also more convenient when a milking machine is used. There is very little work at the mangers during the pasture period.

The investment in buildings per cow, and the charge for their use, was highest in the small herds. Many small herds were housed in additions attached to the main barn, which reduced the cost of shelter. The larger

Costs:								
Grain, summer	$ 634.00	$ 1.37	$ 989.00	$ 2.04	$ 838.00	$ 1.92	$ 1,564.00	$ 2.31
Grain, winter	8,637.00	18.74	8,675.00	17.89	8,546.00	19.60	12,975.00	19 19
Succulent feed	3,594.00	7.80	5,458.00	11.25	2,390.00	5.48	11,070 00	16.38
Dry forage	9,476.00	20.55	9,676.00	19.95	9,842.00	22.57	11,728.00	17.35
Total feed	$22,341.00	$48.46	$24,798.00	$51.13	$21,616.00	$49.57	$37,337.00	$55.23
Pasture	2,310.00	5.01	2,208.00	4.55	1,994.00	4.57	2,826.00	4.18
Bedding	384.00	0.83	514.00	1.06	309.00	0.71	466.00	0.69
Human labor	12,963.35	28.12	12,060.15	24.87	9,946.95	22.81	14,437.55	21.36
Horse labor	329.70	0.72	451.35	0.93	304.20	0.70	606.60	0.90
Hauling milk	4,823.80	10.46	5,031.26	10.37	5,113 33	11.73	4,716.40	6.98
Use of buildings	2,183.88	4.74	2,114.08	4.36	1,686.89	3.87	2,720.84	4.03
Use of equipment	290.10	0.63	242.85	0.50	188.50	0.43	293.65	0.43
Interest on cows	1,485.60	3.22	1,526.75	3.15	1,354.70	3.11	2,290.35	3 39
Interest on feed and supplies	333.00	0.72	342.00	0.71	307.50	0.71	529.00	0.78
Depreciation on cows	1,198.00	2.60	1,403.00	2.89	1,280.00	2.94	1,841.00	2.72
Bull service	404.10	0.88	462.61	0.95	369.42	0.85	735.17	1.09
Miscellaneous	805.00	1.75	862.00	1.78	732.00	1.68	1,097.00	1.62
Total costs	$49,851.53	$108.14	$52,016.05	$107.25	$45,202.49	$103.68	$69,896.56	$103.40
Returns:								
Milk sold	$36,861.53	$79.96	$38,207.68	$78.78	$34,776.34	$79.76	$61,706.67	$91.28
Milk products sold	127.69	0.28	115.07	0.24	100.00	0.23	....	....
Milk and milk products used	4,285.82	9.30	3,537.10	7.29	2,794.14	6.41	3,956 95	5.85
Calves and calf hides	952.00	2.07	936.00	1.93	814.00	1.87	1,906.00	2.82
Manure	3,984.77	8.64	4,646.12	9.58	4,488.75	10.30	6,777.00	10.03
Miscellaneous	....	....	165.00	0.34	24.00	0.05	20.00	0.03
Total returns	$46,211.81	$100.25	$47,606.97	$98.16	$42,997.23	$98.62	$74,366.62	$110.01
Loss	3,639.72	7.89	4,409.08	9.09	2,205.26	5.06	....	....
Gain	....	....	....	....	....	....	4,470.06	6.61

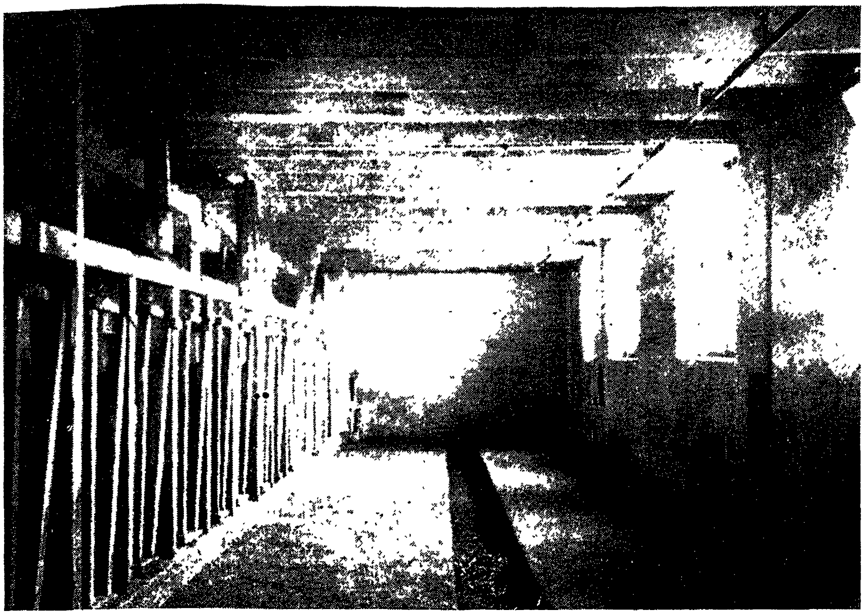

FIG. 57. A WELL-LIGHTED, WELL-VENTILATED, CLEAN, AND COMFORTABLE STABLE

herds were kept in more expensive basements. This increased the cost of shelter. For these reasons the difference in the charge per cow for the use of buildings is relatively little between small and large herds.

Costs and returns

The cost of keeping a cow was less in the larger herds. Partly because of this, but also because the returns were better, there was a greater profit per cow in the larger herds. In small herds the loss was $8 per cow. In the medium-sized herds the average loss was $9 per cow. But in the larger herds with an average of 23.3 cows there was a gain of about $7 per cow. The figures are given in table 40.

TABLE 41. RELATION OF SIZE OF HERD TO COST OF PRODUCTION AND TO AVERAGE PRICE FOR PRODUCT

	Number of cows per farm							
	6 to 10		10+ to 14		14+ to 18		Over 18	
	Herd cost	Cow cost	Herd cost	Cow cost	Herd cost	Cow cost	Herd cost	Cow cost
Cost per hundred pounds of milk sold	$1.82	$1.80	$1.81	$1.81	$1.74	$1.72	$1.54	$1.54
Per cent of cost (first group taken as 100)	100	100	99	101	96	96	85	86
Cost per pound of butter-fat in milk sold	$0.448	$0.441	$0.454	$0.454	$0.429	$0.424	$0.388	$0.387
Amount received per hundred pounds of milk sold	$1.64		$1.62		$1.61		$1.66	

far as nutriment is concerne
period can be obtained more
season or the other is at a disa
or the stage of lactation of m
the winter period is at a disa
cows were not in milk or wer
by seasons for herds giving m
are presented later.

Length of the seasons.— On
May 14 and ended on Octobe
period comprised 206 days.

How the costs were apportione
ding, and labor for cows, were o
periods. The cost of ice and
period, and interest on feed an
Milk-hauling charges were di
milk produced in the two peri

All the remaining costs were
season. These costs included
on cows, depreciation, bull ser
those previously mentioned.

How the returns were apporti
year was credited to the wint
milk sold during each period we
to apportion milk produced dur
and the winter period accordi
Retail milk, and all other retu
used on the farm, were divide
length. It was not known how
but one-fifth of the butter made
buttermilk sold was credited to

Feed used.— Gluten, wheat f
commonly used in summer. Tw
feeds were used in smaller quant

About two-thirds of the succu
was corn fed green. Very little

The figures for concentrates,
the two periods, are given in tab

But most of the milk made i
which takes the place of all of
Usually some grain and a small
feed are used to supplement the
about 5 pounds of grain and 23

09

, the cow cost of milk was $1.54
erds averaging 8.6 cows the cow
out one-fifth more (table 41).

larger herds, and also more was
all herds. But the small herds
use a larger proportion of those
milked rather than to the block.
; about a year less in large herds
tendency for the owners of large
from small herds.

42:

Proportion of Cows Replaced

mber of cows per farm

to 14	14+ to 18		Over 18	
umber	Number		Number	
Per 100 cows	Total	Per 100 cows	Total	Per 100 cows
6.0	22	5.0	36	5.3
15.0	50	11.5	107	15.8
21.0	72	16.5	143	21.1
.....	4	.....	16	.....
17.7	68	15.6	127	18 8
5.3	33	7.6	93	13.8
9.1	22	5.0	17	2.5
3.3	13	3.0	17	2.5
7.5	7.2		7.1	

y dairy farms, with little else
and a small herd usually means
ich the labor income of these
l. However, studies in other
nditions have shown a striking
of herd, and there is no reason
for these farms. On a small
it is difficult to produce milk

best opportunity to increase
first to enlarge the farm. By
g, and reseeding, some of the
stock. On some farms a few
In these ways the herds may

be increased slightly. But any effective increase in the size of herd in most cases means the farming of more land. Often this may be done by renting or by purchasing. Where less than twelve cows are kept because the farm is too small to support a larger herd, more land is essential. But this does not necessarily imply that there must be enough to keep very large herds. It is doubtful whether such herds would produce milk much

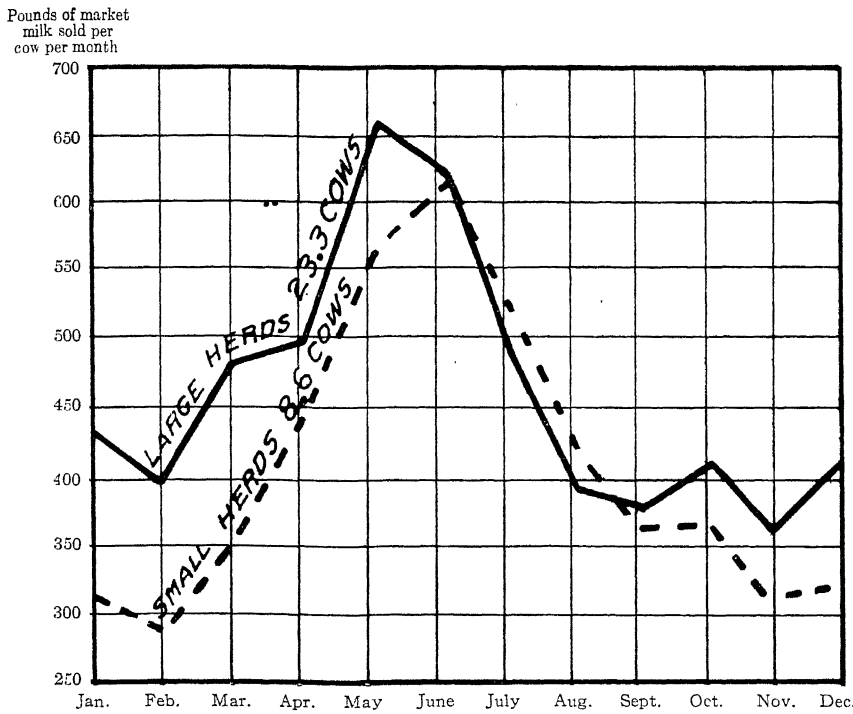

FIG. 58. RELATION OF SIZE OF HERD TO PRODUCTION

With large herds a more intensive system is followed and better production is obtained than with small herds

more economically than herds of from 25 to 50 cows. On the average a 50-cow herd probably requires a farm three times as large as the average farm in the State.

Some farms that are already heavily stocked may find it more profitable not to keep more cows after more acres have been added.

Season of milk production

Summer and winter seasons

Milk-production studies should be based on a year's production rather than on summer or winter periods only, for at least two reasons: first, because the normal lactation of cows is about a year; and secondly, because cows are kept at a heavy loss during a part of the year when dry. So

nutriment is concerned, production at the beginning of a lactation can be obtained more economically than at the end. Hence one or the other is at a disadvantage, according to the time of freshening stage of lactation of most of the cows. In the following comparison nter period is at a disadvantage because at that time many of the vere not in milk or were giving only small quantities. Comparisons sons for herds giving milk distributed more evenly thruout the year esented later.

th of the seasons.— On the average, the pasture season began on 4 and ended on October 19, lasting 159 days. Therefore the winter comprised 206 days.

the costs were apportioned.— The quantities and costs of all feed, bed-nd labor for cows, were obtained separately for the pasture and winter s. The cost of ice and of fly protectors was charged to the pasture and interest on feed and supplies was charged to the winter period. auling charges were divided according to the relative amount of oduced in the two periods.

he remaining costs were apportioned according to the length of the These costs included use of buildings, use of equipment, interest s, depreciation, bull service, and miscellaneous charges other than reviously mentioned.

the returns were apportioned.— All the manure recovered during the is credited to the winter period. The quantities and receipts for d during each period were credited to that period. It was necessary rtion milk produced during May and October to the pasture season winter period according to the days in each of these periods. nilk, and all other returns except cream, butter, and buttermilk the farm, were divided between the periods according to their It was not known how much butter was made during the winter, fifth of the butter made on the farm and one-fifth of the cream and ilk sold was credited to the pasture period.

ised.— Gluten, wheat feed, and wheat bran were the feeds most ly used in summer. Two farmers used wet brewers' grains. Other re used in smaller quantities.

two-thirds of the succulent feed used during the pasture period fed green. Very little hay was used at that time.

gures for concentrates, succulent feed, and dry forage fed during periods, are given in tables 43, 44, and 45, respectively.

ost of the milk made in summer is produced on cheap pasture, kes the place of all of the dry forage and most of the grain. some grain and a small amount of green corn or other succulent used to supplement the pasture late in summer. This averaged ounds of grain and 23 pounds of succulent feed to 100 pounds of

TABLE 43. CONCENTRATES FED IN PASTURE AND WINTER PERIODS, 2058 COWS

Kind of feed	Pasture period: Number of herds using	Pasture period: Number of pounds used	Pasture period: Value	Winter period: Number of herds using	Winter period: Number of pounds used	Winter period: Value
Home-grown:						
Oats	......	....	......	27	69,507	$1,043
Buckwheat	......	....	......	16	25,220	423
Corn	......	....	......	6	13,640	185
Rye	......	....	......	1	2,240	50
Barley	......	....	......	1	1,250	22
Wheat	......	....	......	......	....	....
Total home-grown	......	....	......	......	111,857	$1,723
Purchased:						
Gluten (feed)	54	107,099	$1,623	134	964,906	$14,651
Cornmeal	6	4,360	70	48	121,080	1,954
Hominy	1	8,300	124	5	12,195	187
Corn and oats	......	....	......	1	90	1
Corn bran	1	2,850	11	......	....	....
Corn middlings	1	1,880	17	......	....	....
Wheat feed	31	49,640	768	69	314,296	4,844
Wheat bran	20	20,580	293	63	214,655	3,066
Wheat middlings	......	....	......	7	7,650	117
Buckwheat middlings	1	3,100	50	5	21,900	338
Ground oats	......	....	......	1	3,400	54
Cottonseed meal	10	7,830	127	67	172,311	2,821
Oilmeal	......	....	......	22	7,660	174
Distillers' and brewers' dried grains:						
Continental gluten	......	....	......	4	21,560	361
Dewey's	3	3,600	59	8	32,050	528
Kinds not found	3	1,700	28	6	9,780	161
Dry equivalent of brewers' grains, wet	2	26,808	205	2	33,398	255
Brewers' grains, dried	5	4,020	55	25	84,635	1,187
Malt sprouts	......	....	......	2	5,000	64
Molasses and molasses feeds:						
Molasses	......	....	......	8	9,900	117
Cloverleaf Feed	4	3,980	53	17	68,710	897
Hammond's Dairy	2	1,930	26	2	8,730	116
Ideal	......	....	......	1	10,000	125
International Special	......	....	......	1	10,000	110
Purina	......	....	......	1	7,850	130
Sucrene	......	....	......	2	5,600	86
Xtra Vim	......	....	......	2	2,500	41
Empress	......	....	......	1	2,000	23
International Dairy Feed	......	....	......	1	28,000	349
Sugar Feed	1	400	6	1	2,200	33
Kinds not found	8	5,515	69	22	97,544	1,268
Other mixed feeds:						
Eggee	1	1,000	13	4	24,740	309
Schumacher	7	5,590	88	16	38,285	597
Union grains (Ubiko)	1	5,000	82	3	43,900	716

TABLE 43 (*concluded*)

Kind of feed	Pasture period: Number of herds using	Pasture period: Number of pounds used	Pasture period: Value	Winter period: Number of herds using	Winter period: Number of pounds used	Winter period: Value
Other mixed feeds (*concluded*):						
Unicorn.	4	12,700	$ 216	7	27,220	$ 460
Grandins' Mixed Feed.	2	1,150	19	3	3,150	50
Kinds not found. . .	1	1,200	20	1	1,600	27
Miscellaneous:						
Dried beet pulp. . . .	......	....	......	7	16,300	221
Alfalfa meal.	......	....	......	1	100	2
Condimental feed. .	......	....	......	32	*1,350	324
Salt.	3	1,200	3	141	66,280	346
Total purchased. .	......	281,432	$4,025	......	2,502,525	$37,110
Total concentrates.	......	281,432	$4,025	......	2,614,382	$38,833

*Quantities reported for six farms only.

TABLE 44. SUCCULENT FEED FED IN PASTURE AND WINTER PERIODS, 2058 COWS

Kind of feed	Pasture period: Number of herds using	Pasture period: Number of tons used	Pasture period: Value	Winter period: Number of herds using	Winter period: Number of tons used	Winter period: Value
Home-grown:						
Corn silage.	10	77	$ 386	69	3,818.9	$19,098
Millet silage.	......	....	......	1	20	60
Corn (green).	48	404.75	1,065	3	7.2	35
Sweet corn.	2	7	28	......	....	....
Turnips.	......	....	......	19	106.35	456
Potatoes.	......	....	......	36	70.03	505
Mangels.	1	6.8	34	3	39.6	108
Carrots.	......	....	......	3	7.6	82
Apples.	1	4.8	20	......	....	....
Beets.	......	....	......	2	0.5	5
Cabbage fodder.	4	23	65	3	34	43
Cabbage.	......	....	......	6	30.75	93
Green rowen.	2	36	65	......	....	....
Millet.	8	27.7	117	......	....	....
Oats and peas.	6	27.5	89	......	....	....
Buckwheat.	1	10	100	1	4	8
Oats, corn, and millet.	......	....	......	1	9	27
Oats.	1	2	10	......	....	....
Rye.	......	....	......	1	1.5	8
Purchased:						
Potatoes.	......	....	......	1	1.35	5
Total succulent feed	......	626.55	$1,979	......	4,150.78	$20,533

TABLE 45. DRY FORAGE FED IN PASTURE AND WINTER PERIODS, 2058 COWS

Kind of feed	Pasture period: Number of herds using	Pasture period: Number of tons used	Pasture period: Value	Winter period: Number of herds using	Winter period: Number of tons used	Winter period: Value
Home-grown:						
Mixed hay	1	2	$22	130	2,569.3	$26,392
Timothy hay	1	0.5	6	35	445.45	4,820
Clover hay	......	....	......	7	86.9	999
Clover hay (second cut)	......	....	......	5	20.1	247
Alfalfa hay	......	....	......	11	42.4	608
Oat hay	1	5	50	23	126.05	1,151
Oat and pea hay	......	....	......	20	125.2	1,168
Millet hay	2	2.25	17	17	85.55	775
Straw fed (oat)	......	....	......	20	53.75	264
Straw fed (buckwheat)	......	....	......	5	3.65	14
Corn stover	2	4	11	71	656.2	3,688
Purchased:						
Hay	......	....	......	11	42.75	465
Cornstalks	......	....	......	2	12	25
Total	......	13.75	$106	......	4,269.30	$40,616

milk, or 1 pound of grain and 12 pounds of succulent feed for each pound of butterfat produced.

For each hundred pounds of milk produced in winter, about 44 pounds of grain, 140 pounds of succulent feed, and 144 pounds of dry forage were used. This amounted to 11 pounds of grain, 35 pounds of succulent feed, and 36 pounds of dry forage, per pound of butterfat.

The data are given in table 46:

TABLE 46. FEED USED PER COW PER DAY AND PER UNIT OF PRODUCT, PASTURE AND WINTER PERIODS, 2058 COWS

	Pasture period: Total	Pasture period: Pounds per cow per day	Pasture period: Pounds per 100 pounds of milk produced	Pasture period: Pounds per pound of butterfat produced	Winter period: Total	Winter period: Pounds per cow per day	Winter period: Pounds per 100 pounds of milk produced	Winter period: Pounds per pound of butterfat produced
Grain	281,432 pounds	0.856	5.2	1.3	2,614,382 pounds	6.007	43.9	11.0
Silage	77.00 tons	0.471	2.8	0.7	3,838.9 tons	18.110	129.0	32.2
Other succulent feed	549.55 tons	3.359	20.2	5.0	311.88 tons	1.471	10.5	2.6
Dry forage	13.75 tons	0.084	0.5	0.1	4,269.3 tons	20.141	143.5	35.8
Days of pasture per cow	159	......	6.0	1.5	....	......	....	....
Acres of pasture per cow	3.1	......	....	....	....	......	....	....

Labor required.— The labor required to take care of cows is much less in summer than in winter, but owing to the fact that work on the dairy competes somewhat with crop work in summer, the time spent in summer

is more valuable. Dairymen are willing to work for less in winter than in summer. The difference in the cost of production for the two seasons as shown here does not take account of this.

An average of 67.2 hours per cow was required in summer (table 47). This is 25 minutes per cow per day, 2.55 hours per hundred pounds of milk, and 0.63 hour per pound of butterfat produced. The time in winter was 120.2 hours per cow, 35 minutes per cow per day, 4.16 hours per hundred pounds of milk, and 1.04 hours per pound of butterfat produced.

TABLE 47. LABOR REQUIRED IN PASTURE AND WINTER PERIODS, 2058 COWS

	Total hours	Hours per cow	Minutes per cow per day	Hours per 100 pounds of milk produced	Hours per pound of butterfat produced
Pasture period					
Milking:					
Man	70,159	34.1	13	1.29	0.32
Woman	8,640	4.2	2	0.16	0.04
Child	5,254	2.5	1	0.10	0.02
Total milking	84,053	40.8	16	1.55	0.38
Care of cows, product, and utensils:					
Man	26,420	12.8	5	0.49	0.12
Woman	6,185	3.0	1	0.11	0.03
Child	1,775	0.9	....	0.03	0.01
Hauling feed	35	0.1	....	....	....
Other human labor	618	0.2	....	0.01	....
Total	119,086	57.8	22	2.19	0.54
Hauling milk	19,254	9.4	3	0.36	0.09
Total	138,340	67.2	25	2.55	0.63
Winter period					
Milking:					
Man	86,585	42.1	12	1.45	0.36
Woman	7,819	3.8	1	0.13	0.03
Child	6,897	3.4	1	0.12	0.03
Total milking	101,301	49.3	14	1.70	0.42
Care of cows, product, and utensils:					
Man	107,157	52.1	15	1.80	0.45
Woman	8,285	4.0	1	0.14	0.04
Child	3,095	1.5	1	0.05	0.01
Hauling feed	4,014	1.9	1	0.07	0.02
Other human labor	2,432	1.2	....	0.04	0.01
Total	226,284	110.0	32	3.80	0.95
Hauling milk	21,083	10.2	3	0.36	0.09
Total	247,367	120.2	35	4.16	1.04

Costs and returns.— Feed represented 29 per cent of the cost in summer and 63 per cent of the cost in winter. The value of summer feed used by cows was 30 cents per hundred pounds of milk sold, or 8 cents per pound of butterfat sold, in summer. In winter the value of feed used was $1.85 per hundred pounds of milk sold, or 47 cents per pound of butterfat sold. The average price received during the winter was 36 cents per hundred pounds of milk, or 9 cents per pound of butterfat, higher than that received during the pasture period. But the additional value of feed used in its production was more than four times the difference in price. The large part of the difference in cost of milk in the pasture and winter seasons is due to the great difference in the cost of feed.

The charge for labor during the pasture season was 33 cents per hundred pounds of milk sold, or 8 cents per pound of butterfat sold. In winter it was 60 cents per hundred pounds of milk sold, or 15 cents per pound of butterfat sold. In summer the feed cost and the labor charge are of about equal importance. But in winter labor made up about one-fifth of the cost, and feed nearly two-thirds.

The average yearly selling price of milk did not equal its cost. But the cost of production was 159 per cent higher in winter than in the pasture period. If labor had been charged at a lower rate in winter, and if the summer period had paid for the feed used during winter to get cows into condition for summer production, and if more of the cows had freshened in the fall, the difference would have been less.

The data for costs and returns for the two periods are given in tables 48 and 49, respectively.

Summer and winter dairies

The intensity of the methods of feeding and of taking care of the dairies in winter is adjusted to the price of milk and feed and to other factors, but most largely to the time of year when most of the cows freshen. The most favorable time for freshening, from an economic standpoint, depends on the size of the herd, the distance to the milk station, the soil, the acreage and the kind of crops grown, the abundance and cost of pasture, the cost of winter feed, the relative prices of milk in different months, and many other factors.

In this investigation no record was made of the time when the cows freshened. In view of this, it became necessary to sort the records according to the proportion of summer and winter milk, in order to study the variations in the intensity of methods. Three groups were made: one to include those herds from which less than 33 per cent of the milk was sold during May, June, and July; a second to include herds from which from 33 to 40 per cent of the milk was sold during these months; and a third to include herds from which more than 40 per cent of the milk was sold during these months. The first group thus includes herds with the greatest

TABLE 48. COSTS FOR PASTURE AND WINTER PERIODS, 2058 COWS

Cost items	Pasture period				Winter period			
	Total	Per cow	Per 100 pounds of milk sold	Per pound of butterfat sold	Total	Per cow	Per 100 pounds of milk sold	Per pound of butterfat sold
Grain	$4,025.00	$1.96	$0.08	$0.02	$38,833.00	$18.87	$0.72	$0.18
Silage	386.00	0.19	0.01	0.00	19,158.00	9.31	0.35	0.09
Other succulent feed	1,593.00	0.77	0.03	0.01	1,375.00	0.67	0.03	0.01
Dry forage	106.00	0.05	0.00	0.00	40,616.00	19.74	0.75	0.19
Pasture	9,338.00	4.54	0.18	0.05	......	......	......	......
Total feed	$15,448.00	$7.51	$0.30	$0.08	$99,982.00	$48.59	$1.85	$0.47
Bedding	......	......	......	......	1,673.00	0.81	0.03	0.01
Human labor	16,770.20	8.15	0.33	0.08	32,637.80	15.86	0.60	0.15
Horse labor	2.40	0.00	0.00	0.00	1,689.45	0.82	0.03	0.01
Hauling milk	9,533.20	4.63	0.19	0.05	10,151.59	4.93	0.19	0.05
Use of buildings	3,792.34	1.84	0.07	0.02	4,913.35	2.39	0.09	0.02
Use of equipment	442.19	0.21	0.01	0.00	572.91	0.28	0.01	0.00
Interest on cows	2,900.08	1.41	0.06	0.02	3,757.32	1.83	0.07	0.02
Interest on feed and supplies	......	......	......	......	1,511.50	0.73	0.03	0.01
Bull service	858.73	0.42	0.02	0.00	1,112.57	0.54	0.02	0.00
Depreciation, less value of calves at birth	485.28	0.23	0.01	0.00	628.72	0.31	0.01	0.00
Ice, and sawdust for ice	1,764.00	0.86	0.03	0.01	......	......	......	......
Fly protectors	259.00	0.13	0.01	0.00	......	......	......	......
Other miscellaneous costs	642.00	0.31	0.01	0.00	831.00	0.40	0.02	0.00
Total	$52,897.42	$25.70	$1.04	$0.26	$159,461.21	$77.49	$2.95	$0.74

TABLE 49. RETURNS FOR PASTURE AND WINTER PERIODS, 2058 COWS

Returns from	Pasture period						Winter period					
	Pounds of milk	Pounds of butter-fat	Total value	Value per cow	Value per 100 pounds of milk sold	Value per pound of butter-fat sold	Pounds of milk	Pounds of butter-fat	Total value	Value per cow	Value per 100 pounds of milk sold	Value per pound of butter-fat sold
Milk sold:												
May (13 days)							529,859	20,665	$ 6,783.57			
May (18 days)	733,652	28,612	$ 9,392 63									
June	1,277,921	49,839	15,427.53									
July	1,031,219	41,249	14,038.80									
August	804,535	32,986	12,468.13									
September	729,411	30,635	12,322.50									
October (19 days)	464,542	19,511	9,107.02									
October (12 days)							293,395	12,322	5,751.81			
November							678,288	28,488	13,955.19			
December							710,820	29,854	14,668.57			
January							735,854	29,434	14,693.08			
February							674,841	26,319	12,700 94			
March							813,750	31,736	14,673 42			
April							924,341	36,049	13,941.59			
Retail (159 days)	30,841	1,296	708 94									
Retail (206 days)							39,957	1,678	918 50			
Total	5,072,121	204,128	$73,465.55	$35.70	$1.45	$0.36	5,401,105	216,545	$98,086 67	$47.66	$1.81	$0.45
Milk products sold							1,215	903	$ 342.76			
Milk used	333,665	13,347	$5,437 21				432,295	17,292	7,044.43			
Skimmilk and buttermilk used	27,707		55.55				110,826		222.21			
Butter used	1,131	962	326.79				4,525	3,846	1,307 18			
Cream used	200	40	36 13				800	160	144 51			
Manure recovered									19,896.64			
Board of cows									52 00			
Hauling milk			68.39						88.61			
Total	362,703	14,349	$5,924 07	$2 88	$0 11	$0.03	549,661	22,201	$29,098.34	$14.14	$0.54	$0 14
Grand total	5,434,824	218,477	$79,389.62	$38.58	$1.56	$0.39	5,950,766	238,746	$127,185.01	$61.80	$2 35	$0.59
Difference (costs less returns)			+$26,492.20	+$12.88	+$0.52	+$0 13			-$32,276.20	-$15.69	-$0.60	-$0.15
Cost at market			$46,973.35		$0.93	$0 23			$130,362.87		$2.41	$0.60

tendency toward winter dairying, producing about 54 per cent of the milk in the six months from November to April inclusive. These herds produced milk distributed by seasons, but not by months, about as needed in the New York market. Some of the cows freshened in the spring, but many of them freshened in the fall. The last group included largely summer dairies producing about 30 per cent of the milk in the six winter months from November to April inclusive. Probably most of the cows in these herds freshened in the spring. The middle group is made up of herds with a lesser tendency toward either winter or summer dairying.

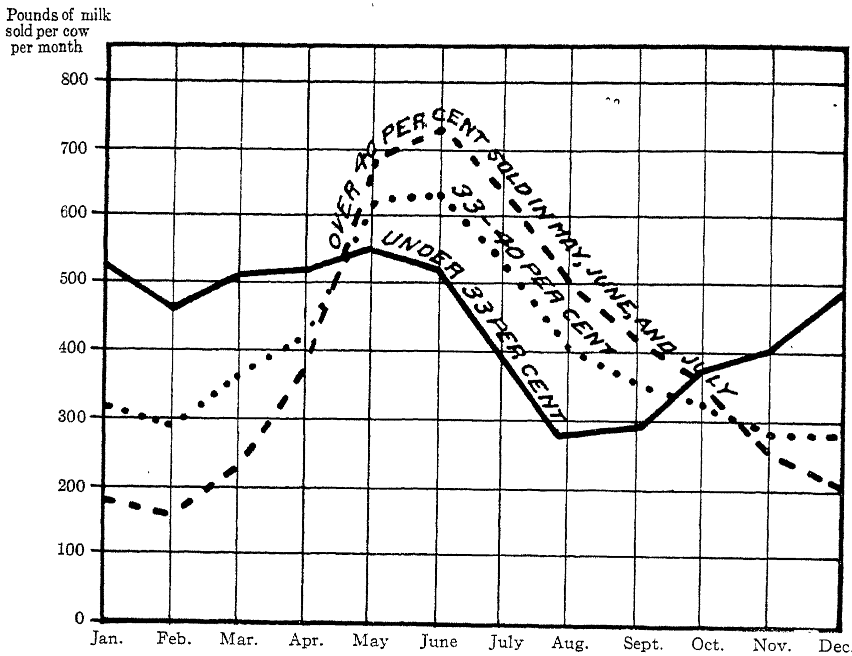

FIG. 59. DISTRIBUTION OF PRODUCTION IN SUMMER AND WINTER DAIRIES

Farms producing more summer milk were smaller and had smaller herds. They were about as heavily stocked, however, as farms on which a larger proportion of the milk was made in winter. The distance to market was much the same, but more of the summer dairies were on the uplands.

The hill sections are unfavorable to the cheapest production of silage, principally because of a shorter growing season and poor soil. It is therefore to be expected that a smaller proportion of the summer dairies should feed silage. This influences the intensity of winter feeding, and thus, to some extent, the proportion of milk made in summer. Probably many of the summer dairies are too small to make profitable use of a silo.

A larger proportion of winter dairies used purebred bulls. This is another indication of a more intensive system.

The relation of the season of production to various factors is shown in table 50:

TABLE 50. RELATION OF SEASON OF PRODUCTION TO VARIOUS FACTORS

	Per cent of milk sold during May, June, and July		
	Less than 33	From 33 to 40	More than 40
Number of farms	56	52	41
Acres per farm	168	156	142
Miles to market	3.5	3.2	3.4
Number of farms on upland	31	34	34
Number of farms in valleys	25	18	7
Per cent of farms on upland	55	65	83
Per cent of farms in valleys	45	35	17
Number of cows	798	757	503
Cows per farm	14.2	14.6	12.3
Number of cattle units	1,045.6	959.1	665.6
Cattle units per farm	18.7	18.4	16.2
Number using purebred bulls	18	12	9
Per cent using purebred bulls	32	23	22
Number feeding silage	34	25	10
Per cent feeding silage	61	48	24
Value of cows per head	$66.61	$62.72	$64.63

Production per cow and its distribution.— Production was better in herds that produced a larger proportion of milk in winter. This was due largely to fall freshening and to more intensive feeding rather than to more efficient cows, altho it is probable that better cows were kept.

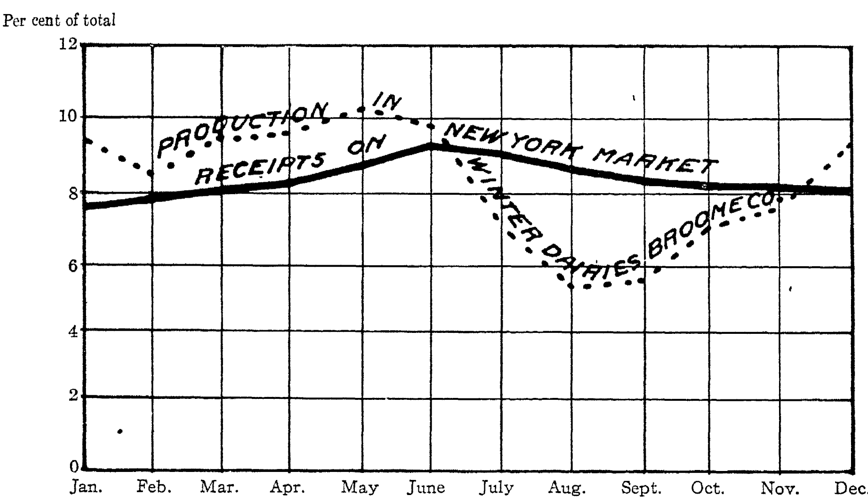

FIG. 60. PRODUCTION IN WINTER DAIRIES IN BROOME COUNTY AS COMPARED WITH RECEIPTS ON THE NEW YORK MARKET

In winter dairies the lowest production comes in August and September, when summer herds also are falling off rapidly

TABLE 51. RELATION OF SEASON OF PRODUCTION TO PRODUCTION AND ITS DISTRIBUTION

	Less than 33 per cent of milk sold during May, June, and July					From 33 to 40 per cent of milk sold during May, June, and July					More than 40 per cent of milk sold during May, June, and July				
	Pounds of milk per cow	Per cent of milk sold	Average per cent of butter-fat	Pounds of butter-fat per cow	Per cent of receipts for milk sold	Pounds of milk per cow	Per cent of milk sold	Average per cent of butter-fat	Pounds of butter-fat per cow	Per cent of receipts for milk sold	Pounds of milk per cow	Per cent of milk sold	Average per cent of butter-fat	Pounds of butter-fat per cow	Per cent of receipts for milk sold
Milk sold:															
May	554	10.3	3.9	21.6	7.9	626	12.6	3.9	24.4	9.9	691	14.4	3.9	26.9	11.6
June	526	9.7	4.0	21.0	7.0	641	12.9	3.9	25.0	9.7	741	15.4	4.0	29.6	11.9
July	383	7.1	4.0	15.3	5.6	534	10.8	4.0	21.4	9.2	639	13.3	4.0	25.6	11.7
August	292	5.4	4.1	12.0	5.0	415	8.4	4.1	17.0	8.1	511	10.6	4.1	21.0	10.5
September	295	5.5	4.2	12.4	5.5	369	7.5	4.2	15.5	7.8	428	8.9	4.3	18.4	9.5
October	387	7.2	4.1	15.9	8.3	347	7.0	4.2	14.6	8.5	370	7.7	4.3	15.9	9.6
November	410	7.6	4.1	16.8	9.2	295	6.0	4.1	12.1	7.6	255	5.3	4.4	11.2	7.0
December	484	9.0	4.2	20.3	10.8	293	5.9	4.1	12.0	7.5	205	4.2	4.5	9.2	5.7
January	513	9.5	4.0	20.5	11.1	312	6.3	4.0	12.5	7.7	180	3.7	4.5	8.1	4.8
February	465	8.6	3.9	18.1	9.6	298	6.0	3.8	11.3	6.9	155	3.2	4.0	6.2	3.9
March	514	9.5	4.0	20.6	10.1	371	7.5	3.9	14.5	8.4	242	5.0	3.9	9.4	5.8
April	516	9.6	4.0	20.6	8.6	423	8.5	3.9	16.5	7.9	383	8.0	3.8	14.6	7.5
Retail	53	1.0	4.1	2.2	1.3	28	0.6	4.3	1.2	0.8	15	0.3	4.1	0.6	0.5
Total	5,392	100.0	4.0	217.3	100.0	4,952	100.0	4.0	198.0	100.0	4,815	100.0	4.1	196.7	100.0
Milk not sold	430	.....	4.0	17.2	......	460	.....	4.0	18.4	......	440	.....	4.1	18.0	......
Total	5,822	.....	......	234.5	......	5,412	.....	......	216.4	......	5,255	.....	......	214.7	......

In winter dairies the average production was 5822 pounds of milk containing 234.5 pounds of butterfat, and in summer dairies it was 5255 pounds of milk and 214.7 pounds of butterfat (table 51).

As much milk per cow was produced in November, December, and January, as in May, June, and July, in winter dairies, while in summer dairies the amount was less than one-third as much in the winter months. The average test was higher in the summer dairies, especially in the winter months.

Feed used.— The amounts and kinds of feeds used in relation to season of production are shown in tables 52 to 56.

Less grain and less succulent feed, but more dry forage, was used per cow and per unit of product when a larger proportion of the milk was produced in summer. More of the feed for summer dairies was furnished by pasture. When a summer system is followed, many of the cows give little or no milk in winter. They are kept very largely on dry fodder, with only enough grain to get them in fair condition for spring freshening. This is the cheapest way to produce milk. But milk produced on this system becomes an important factor on the market in April, and thus the April price is lower than the price for the other months of barn feeding. Such a system is common in cheese and butter sections, and to a less extent in condensing sections, because these products are made largely in summer and stored for winter use. However, only a few dairies furnishing milk for city markets follow the summer system, because cities use about the same amount of milk the year round. To produce milk on such a basis is more costly, and hence consumers cannot expect market milk to be as cheap as milk for manufacturing purposes. It has been estimated that in 1918, 47 per cent of the liquid milk sold in New York State was manufactured.[10] The prices which producers receive must compensate for the greater expense in producing certified, retail, Grade A, or Grade B milk, or else such producers will turn to less expensive systems.

Summer dairies use much more feed in winter per unit of product, but they also use much less in summer, so that the yearly average is less than for winter dairies.

Labor required.— The total amounts and value of labor used per cow and per unit of product in herds of varying season of production are given in tables 57 to 59.

Less time was spent per cow in summer dairies than in winter dairies. But since the production also was less, nearly as much time was required per unit of product as when more of the milk was made in winter. An average of 22 minutes per cow per day in summer, and 36 minutes in winter, was used in herds following winter dairying. In the summer dairies these figures were 23 minutes in summer and 29 minutes in winter.

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[10] Bulletin 118, New York State Department of Farms and Markets.

TABLE 52. CONCENTRATES USED BY COWS IN THREE SEASONAL GROUPS

Kind of feed	Less than 33 per cent of milk sold during May, June, and July						From 33 to 40 per cent of milk sold during May, June, and July						More than 40 per cent of milk sold during May, June, and July					
	Pasture period			Winter period			Pasture period			Winter period			Pasture period			Winter period		
	Number of herds using	Number of pounds used	Value	Number of herds using	Number of pounds used	Value	Number of herds using	Number of pounds used	Value	Number of herds using	Number of pounds used	Value	Number of herds using	Number of pounds used	Value	Number of herds using	Number of pounds used	Value
Home-grown:																		
Oats				9	19,922	$306				11	41,285	$612				7	8,300	$125
Buckwheat				7	13,760	235				5	7,960	127				4	3,500	61
Corn				1	840	11				3	9,700	134				2	3,100	40
Rye										1	2,240	50						
Barley				1	1,250	22												
Total home-grown					35,772	$574					61,185	$923					14,900	$226
Purchased:																		
Gluten (feed)	22	29,570	$454	51	431,570	$6,562	18	48,999	$732	46	332,356	$5,030	44	28,530	$437	37	200,980	$3,059
Cornmeal	4	2,260	36	16	43,655	708	2	2,100	34	18	48,810	784				14	28,615	462
Hominy										3	1,570	26	1	8,300	124	2	10,625	161
Corn and oats																1	90	1
Corn bran	1	2,850	11															
Corn middlings	1	1,880	17															
Wheatfeed	12	14,330	220	22	109,125	1,666	8	15,610	239	25	110,431	1,711	11	19,700	309	22	91,740	1,467
Wheat bran	8	6,660	94	28	102,670	1,465	8	11,050	157	18	79,485	1,135	4	2,870	42	17	32,500	466
Wheat middlings				2	1,700	27				4	5,850	88				1	100	2
Buckwheat middlings	1	3,100	50	2	16,900	265				3	5,000	73						
Ground oats				1	3,400	54												
Cottonseed meal	6	2,980	47	34	99,367	1,627	3	4,250	70	20	49,744	812	1	600	10	13	23,200	382
Oilmeal				6	2,200	67				9	3,900	75				7	1,560	32
Distillers' and brewers' dried grains:																		
Continental gluten				2	18,300	306				2	3,260	55						
Dewey's	2	1,800	29	5	23,000	377	1	1,800	30	3	9,050	151						
Kinds not found	1	250	4	3	4,030	63	1	450	8	1	2,250	38	1	1,000	16	2	3,500	60
Dry equivalent of brewers' grains, wet	2	26,808	205	2	33,398	255												
Brewers' grains, dried	1	1,800	24	9	54,315	757	1	1,060	15	7	17,590	249	2	1,160	16	8	12,730	181
Malt sprouts				1	4,000	50				1	1,000	14						
Molasses and molasses feeds:																		
Molasses				2	3,700	42				2	1,800	24				4	4,400	51
Cloverleaf Feed	3	2,880	38	9	40,375	526	1	1,100	15	7	25,035	327				1	3,300	44
Hammond's Dairy	2	1,930	26	2	8,730	116												
Ideal										1	10,000	125						
International Special										1	10,000	110						
Purina																1	7,850	130
Sucrene										2	5,600	86						

Xtra Vim				1	2,000	33				1	500	8						
Empress				1	2,000	23												
International Dairy Feed				1	28,000	349												
Sugar Feed	1	400	6	1	2,200	33												
Kinds not found				4	21,915	281	3	2,715	33	9	49,264	646	5	2,800	36	9	26,365	341
Other mixed feeds:																		
Eggee	1	1,000	13	4	24,740	309												
Schumacher	3	1,450	24	6	21,230	329	2	2,640	42	8	10,300	160	2	1,500	22	2	6,755	108
Union grains (Ubiko)	1	5,000	82	2	33,900	544										1	10,000	172
Unicorn	1	2,100	36	3	7,600	129	2	9,100	154	2	15,520	265	1	1,500	26	2	4,100	66
Grandins' Mixed Feed	1	250	4	1	750	12	1	900	15	2	2,400	38						
Kinds not found	1	1,200	20	1	1,600	27												
Miscellaneous:																		
Dried beet pulp				3	10,800	147				1	2,000	24				3	3,500	50
Alfalfa meal										1	100	2						
Condimental feed				11	700	118				12	350	158				9	300	48
Salt	2	1,000	2	51	25,423	136	1	200	1	52	25,267	131				38	15,590	79
Total purchased		111,498	$1,442		1,183,293	$17,403		101,974	$1,545		828.432	$12,345		67,960	$1,038		490,800	$7,362
Total concentrates		111,498	$1,442		1,219,065	$17,977		101,974	$1,545		889.617	$13,268		67,960	$1,038		505,700	$7,588

TABLE 53. SUCCULENT FEED USED BY COWS IN THREE SEASONAL GROUPS

Kind of feed	Less than 33 per cent of milk sold during May, June, and July						From 33 to 40 per cent of milk sold during May, June, and July						More than 10 per cent of milk sold during May, June, and July					
	Pasture period			Winter period			Pasture period			Winter period			Pasture period			Winter period		
	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value
Home-grown.																		
Corn silage	7	58.7	$294	31	2,172.7	$10,865	3	18.3	$ 92	25	1,327.35	$6,638	.....	.....	.....	10	318.85	$1,595
Millet silage	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	20	60	.....	.....	.....	.....	.....	.....
Corn (green)	14	133	377	.....	.....	.....	19	156.75	376	2	3.5	17	15	115	$312	1	3.7	18
Sweet corn	2	7	28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Turnips	.....	.....	.....	6	16.3	91	.....	.....	.....	10	76.8	284	.....	.....	.....	3	13.25	81
Potatoes	.....	.....	.....	14	24.85	152	.....	.....	.....	10	20.7	165	.....	.....	.....	11	21.48	188
Mangels	1	6.8	34	2	38.7	106	.....	.....	.....	1	0.9	2	.....	.....	.....	.....	.....	.....
Carrots	.....	.....	.....	2	2.6	32	.....	.....	.....	1	5	50	.....	.....	.....	.....	.....	.....
Apples	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	4.8	20	.....	.....	.....
Beets	.....	.....	.....	1	0.2	2	.....	.....	.....	1	0.3	3	.....	.....	.....	.....	.....	.....
Cabbage fodder	3	13	25	1	30	30	1	10	40	2	4	13	.....	.....	.....	.....	.....	.....
Cabbage	.....	.....	.....	5	27.75	87	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	3	6
Green rowen	.....	.....	.....	.....	.....	.....	1	30	50	.....	.....	.....	1	6	15	.....	.....	.....
Millet	5	20.5	74	.....	.....	.....	2	5.7	31	.....	.....	.....	1	1.5	12	.....	.....	.....
Oats and peas	4	16	48	.....	.....	.....	2	11.5	41	.....	.....	.....	.....	.....	.....	.....	.....	.....
Buckwheat	.....	.....	.....	1	4	8	1	10	100	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oats, corn, and millet	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	9	27
Oats	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	10	.....	.....	.....
Rye	.....	.....	.....	1	1.5	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Purchased:																		
Potatoes	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1.35	5
Total succulent feed	.....	255.0	$880	.....	2,318.6	$11,381	.....	242.25	$730	.....	1,458.55	$7,232	.....	129.3	$369	.....	373.63	$1,920
Total for year	2,573.6 tons, value $12,261						1,700.8 tons, value $7,962						502.93 tons, value $2,289					

TABLE 54. DRY FORAGE USED BY COWS IN THREE SEASONAL GROUPS

Kind of feed	Less than 33 per cent of milk sold during May, June, and July						From 33 to 40 per cent of milk sold during May, June, and July						More than 40 per cent of milk sold during May, June, and July					
	Pasture period			Winter period			Pasture period			Winter period			Pasture period			Winter period		
	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value
Home-grown:																		
Mixed hay	1	2	$22	45	934.4	$9,561	...	...	...	46	939.75	$9,922	...	...	...	39	695.15	$6,909
Timothy hay	1	0.5	6	18	236.05	2,572	...	...	...	11	141.7	1,497	...	...	...	6	67.7	751
Clover hay	...	...	...	4	72.3	858	...	...	...	2	12.6	121	...	...	...	1	2	20
Clover hay (second cut)	...	...	...	2	11	150	...	...	...	3	9.1	97	...	...	...	...	...	...
Alfalfa hay	...	...	...	8	32.4	485	...	...	...	1	3	45	...	...	...	2	7	78
Oat hay	...	...	...	11	59.75	549	1	5	$50	5	23.5	232	...	...	...	7	42.8	370
Oat and pea hay	...	...	...	8	53.2	502	...	...	...	8	53.5	491	...	...	...	4	18.5	175
Millet hay	1	0.25	1	8	29.25	285	...	...	...	5	19.3	184	1	2	$16	1	37	306
Oat straw	...	...	...	5	11	72	...	...	...	9	16.75	93	...	...	...	6	26	99
Buckwheat straw	...	...	...	1	1	3	...	...	...	3	1.65	6	...	...	...	1	1	5
Corn stover	1	3	6	23	229.5	1,291	...	...	...	26	227.05	1,326	1	1	5	22	199.65	1,071
Purchased:																		
Hay	...	...	...	3	14.25	161	...	...	...	4	12.5	127	...	...	...	4	16	177
Cornstalks	...	...	...	2	12	25	...	...	...	...	...	...	...	...	...	...	...	...
Total dry forage		5.75	$35	...	1,696.1	$16,514	...	5	$50	...	1,460.4	$14,141	...	3	$21	...	1,112.8	$9,961
Total for year	1,701.85 tons, value $16,549						1,465.4 tons, value $14,191						1,115.8 tons, value $9,982					

TABLE 55. AMOUNTS OF FEED USED PER COW AND PER UNIT OF PRODUCT IN THREE SEASONAL GROUPS

	Less than 33 per cent of milk sold during May, June, and July*			From 33 to 40 per cent of milk sold during May, June, and July			More than 40 per cent of milk sold during May, June, and July		
	Pounds			Pounds			Pounds		
	Per cow	Per 100 pounds of milk produced	Per pound of butterfat produced	Per cow	Per 100 pounds of milk produced	Per pound of butterfat produced	Per cow	Per 100 pounds of milk produced	Per pound of butterfat produced
Grain	1,668	28.6	7 2	1,310	24.2	6.0	1,140	21.7	5.3
Silage	5,592	96 1	24.0	3,555	65.7	16.4	1,268	24.1	5.9
Other succulent feed	858	14.7	3.7	938	17.3	4 3	732	13.9	3.4
Dry forage	4,265	73.3	18.3	3,872	71.5	17.9	4,437	84.4	20.6
Days of pasture	158	2.7	...	160	3.0	......	161	3.1	....
Acres of pasture	3.1	.....	.....	2.9	.....	......	3.4	......	....

* The data for this group of herds were used with data for other regions in the "Warren formula" averages, as given in Circular 186, New York State Department of Farms and Markets, April, 1919, pages 4–5.

TABLE 56. AMOUNTS OF FEED USED PER 100 POUNDS OF MILK IN PASTURE AND WINTER PERIODS IN THREE SEASONAL GROUPS

	Less than 33 per cent of milk sold during May, June, and July	From 33 to 40 per cent of milk sold during May, June, and July	More than 40 per cent of milk sold during May, June, and July
Pasture period:			
Grain	6.2	4.9	4.3
Silage	6.6	1.8	....
Other succulent feed	22.0	21.6	16.4
Dry forage	0.6	0.5	0.4
Winter period:			
Grain	42.6	43.9	47.5
Silage	151.9	133.1	59.9
Other succulent feed	10.2	11.0	10.3
Dry forage	118.5	144.2	209.1

Excluding milk hauling, the average time spent in summer was 2.56 hours per hundred pounds of milk produced for winter dairies, and 2 hours for summer dairies. In winter the average time was 3.49 hours and 4.72 hours, respectively. Hauling the milk increased these figures .28 hour for winter dairies and 0.44 hour for summer dairies.

A larger proportion of the labor is done by women and children on summer than on winter dairies. The time spent by women and children averaged 19.1 hours, 25.3 hours, and 27.1 hours, per cow for the respective groups. This was respectively 10.4 per cent, 16.2 per cent, and 16.6 per cent, of the total time spent per cow. Most of the extra work was in milking, the time in taking care of dairy utensils, product, and cows being about the same for each group. Since this woman and child labor was charged

TABLE 57. LABOR USED FOR COWS IN THREE SEASONAL GROUPS

	Less than 33 per cent of milk sold during May, June, and July			From 33 to 40 per cent of milk sold during May, June, and July			More than 40 per cent of milk sold during May, June, and July		
	Number of farms using	Number of hours	Value	Number of farms using	Number of hours	Value	Number of farms using	Number of hours	Value
Human labor:									
Milking:									
Man	56	69,277	$10,391.55	52	52,247	$ 7,837.05	41	35,220	$ 5,283.00
Woman	6	2,987	298.70	15	6,897	689.70	16	6,575	657.50
Child	9	4,586	458.60	11	4,595	459.50	6	2,970	297.00
Care of cows, product, and utensils:									
Man	56	57,053	8,557.95	51	44,722	6,708.30	41	31,802	4,770.30
Woman	41	4,692	469.20	46	5,922	592.20	34	3,856	385.60
Child	8	2,949	294.90	7	1,732	173.20	3	189	18.90
Hauling feed	44	2,018	302.70	34	1,182	177.30	25	849	127.35
Hauling milk:									
Man	30	11,930	1,789.50	28	14,078	2,111.70	30	10,689	1,603.35
Woman	1	60	6.00	3	442	44.20	5	506	50.60
Child	3	996	99.60	3	1,090	109.00	1	546	54.60
Other human labor	15	2,084	312.60	11	583	87.45	6	383	57.45
Total labor for cows:									
Man	......	142,362	21,354 30	....	112,812	16,921.80	......	78,943	11,841.45
Woman	.....	7,739	773.90	....	13,261	1,326.10	......	10,937	1,093.70
Child	......	8,531	853.10	......	7,417	741.70	......	3,705	370.50
Total human labor	......	158,632	$22,981.30	......	133,490	$18,989.60	......	93,585	$13,305.65
Horse labor:									
Hauling milk	......	18,522	$2,778.30	......	22,587	$3,388.05	......	17,281	$2,592.15
Other horse labor	.....	5,260	789.00	......	3,621	543.15	......	2,398	359.70
Total horse labor	......	23,782	$3,567.30	......	26,208	$3,931.20	.....	19,679	$2,951.85
Cash paid for hauling milk	38	....	$2,304.35	29	....	$1,767.33	20	......	$986.06

TABLE 58. LABOR PER COW AND PER UNIT OF PRODUCT IN THREE SEASONAL GROUPS

	Less than 33 per cent of milk sold during May, June, and July			From 33 to 40 per cent of milk sold during May, June, and July			More than 40 per cent of milk sold during May, June, and July		
	Hours per cow	Hours per 100 pounds of milk produced	Hours per pound of butterfat produced	Hours per cow	Hours per 100 pounds of milk produced	Hours per pound of butterfat produced	Hours per cow	Hours per 100 pounds of milk produced	Hours per pound of butterfat produced
Human labor:									
Milking:									
Man	86.8	1.49	0.37	69.0	1.28	0.32	70.0	1.33	0.33
Woman	3.7	0.06	0.02	9.1	0.17	0.04	13.1	0.25	0.06
Child	5.8	0.10	0.02	6.1	0.11	0.03	5.9	0.12	0.03
Total	96.3	1.65	0.41	84.2	1.56	0.39	89.0	1.70	0.42
Care of cows, product, and utensils:									
Man	71.5	1.23	0.31	59.1	1.09	0.27	63.2	1.20	0.30
Woman	5.9	0.10	0.02	7.8	0.14	0.04	7.7	0.15	0.03
Child	3.7	0.06	0.02	2 3	0.04	0.01	0.4	0.01	0.00
Hauling feed	2.5	0.05	0.01	1.5	0 03	0.01	1.7	0.03	0.01
Other human labor	2.6	0.05	0.01	0.8	0.02	......	0.7	0.01	....
Total	182.5	3.14	0 78	155.7	2.88	0.72	162.7	3.10	0.76
Hauling milk	16.3	0.28	0.07	20.6	0.38	0.09	23.3	0.44	0.11
Total human labor	198.8	3.42	0.85	176.3	3.26	0.81	186.0	3.54	0.87
Horse labor:									
Hauling milk	23.2	0.40	0.10	29.8	0.55	0.14	34.3	0.65	0.16
Other horse labor	6.6	0.11	0.03	4.8	0.09	0.02	4.8	0.09	0.02
Total horse labor	29.8	0.51	0.13	34.6	0.64	0.16	39.1	0.74	0.18

TABLE 59. LABOR IN PASTURE AND WINTER PERIODS BY SEASONAL GROUPS

	Less than 33 per cent of milk sold during May, June, and July				From 33 to 40 per cent of milk sold during May, June, and July				More than 40 per cent of milk sold during May, June, and July			
	Total hours	Hours per cow	Hours per 100 pounds of milk produced	Minutes per cow per day	Total hours	Hours per cow	Hours per 100 pounds of milk produced	Minutes per cow per day	Total hours	Hours per cow	Hours per 100 pounds of milk produced	Minutes per cow per day
Pasture period:												
Milking:												
Man	28,849	36.1	....	14	23,842	31.5	....	12	17,468	34.7	....	13
Woman	1,427	1.8	....	1	3,536	4.7	....	2	3,677	7.3	....	3
Child	1,916	2.4	....	1	2,138	2.8	....	1	1,200	2.4	....	1
Total	......	......	....	16	......	......	....	15	......	......	....	17
Care of cows, product, and utensils:												
Man	10,267	12.9	....	5	8,907	11.8	....	5	7,246	14.4	....	5
Woman	1,963	2.5	....	1	2,438	3.2	....	1	1,784	3.5	....	1
Child	813	1.0	....	......	773	1.0	....	......	189	0.4	....	......
Total	......	......	....	......	......	......	....	......	......	......	....	......
Hauling feed	......	......	....	......	35	......	....	......	......	......	....	......
Other human labor	472	0.6	....	......	120	0.2	....	......	26	0.1	....	......
Total	45,707	57.3	2.56	22	41,789	55.2	2.02	21	31,590	62.8	2.00	23
Winter period:												
Milking:												
Man	40,428	50.7	....	15	28,405	37.5	....	11	17,752	35.3	....	10
Woman	1,560	2.0	....	1	3,361	4.4	....	1	2,898	5.8	....	2
Child	2,670	3.3	....	1	2,457	3.3	....	1	1,770	3.5	....	1
Total	......	......	....	17	......	......	....	13	......	......	....	13
Care of cows, product, and utensils:												
Man	46,786	58.6	....	17	35,815	47.3	....	14	24,556	48.8	....	14
Woman	2,729	3.4	....	1	3,484	4.6	....	1	2,072	4.1	....	1
Child	2,136	2.7	....	1	959	1.3	....	......	......	......	....	......
Total	......	......	....	......	......	......	....	......	......	......	....	......
Hauling feed	2,018	2.5	....	......	1,147	1.5	....	1	849	1.7	....	1
Other human labor	1,612	2.0	....	......	463	0.6	....	......	357	0.7	....	......
Total	99,939	125.2	3.49	36	76,091	100.5	3.76	29	50,254	99.9	4.72	29

at a lower rate than man labor, it tends to reduce the cost of labor for the summer herds. By thus working the whole family, it is often possible to save the expense of a hired man. Should these summer dairies back on the hills attempt winter dairying instead, in many cases the size of the herd would have to be reduced in order to be carried thru on the roughage that the farm would provide. This would mean that pasture would not be utilized to the fullest extent, and probably that more hired labor would be needed. It would mean also that it would be necessary not only for one, but for many, of these dairies to change in order to justify a special trip thru the section for the milk in parts of the winter. Under these circumstances it is a question whether a change to winter dairying with the prices prevailing when this study was made would increase the profits on the farms studied.

Combined effect of size of herd and season of production on labor required.— Since less labor is required in large herds and when a large proportion of the milk is produced in summer, it is to be expected that in the larger summer dairies the least labor per cow and per unit of product will be necessary. The data on this subject are given in table 60:

TABLE 60. RELATION OF SIZE OF HERD AND SEASON OF PRODUCTION TO LABOR PER COW AND PER UNIT OF PRODUCT

Per cent of milk sold during May, June, and July	Number of cows per farm: 6 to 10		10+ to 14		14+ to 18		Over 18	
	Hours per cow	Hours per 100 pounds of milk produced	Hours per cow	Hours per 100 pounds of milk produced	Hours per cow	Hours per 100 pounds of milk produced	Hours per cow	Hours per 100 pounds of milk produced
Less than 33 per cent:								
Hauling milk	15	0.25	16	0.30	22	0.42	14	0.23
Other labor	202	3.39	197	3.66	186	3.54	161	2.57
Total	217	3.64	213	3.96	208	3.96	175	2.80
From 33 to 40 per cent:								
Hauling milk	29	0.55	14	0.27	31	0.57	16	0.29
Other labor	186	3.51	167	3.16	150	2.78	139	2.50
Total	215	4.06	181	3.43	181	3.35	155	2.79
More than 40 per cent:								
Hauling milk	20	0.40	36	0.67	24	0.44	7	0.12
Other labor	199	4.02	170	3.19	136	2.51	125	2.33
Total	219	4.42	206	3.86	160	2.95	132	2.45

Other costs and returns by seasonal groups.— Details for costs other than feed and labor, and of the returns for summer and winter dairies, are given in tables 61 to 74.

Cows had a higher value, higher prices were paid for cows purchased, and more was received for cows sold, when the system was more intensive.

Cows are replaced more frequently in winter dairies than in summer dairies. More heifers per hundred cows freshen each year, and more

cows are purchased, in winter dairies. A larger share of the cows sold from winter dairies go to the butcher. The size of the winter herds on the farms studied increased; in summer dairies there were less cows at the end of the year than at the beginning.

TABLE 61. COST OF PASTURE

	Less than 33 per cent of milk sold during May, June, and July		From 33 to 40 per cent of milk sold during May, June, and July		More than 40 per cent of milk sold during May, June, and July	
Acres pastured	3,215.5		2,572		2,140	
Value per acre	$21.44		$19.84		$18.95	
Total value	$68,945		$51,018		$40,546	
Days pastured	158		160		161	
	Number of farms	Value	Number of farms	Value	Number of farms	Value
Charges:						
Interest and taxes at 5.5 per cent	56	$3,792	52	$2,806	41	$2,230
Making and repairing fences	56	890	51	939	40	566
Mowing and reseeding	3	46	2	23	....	....
Fertilizing and manuring	....	......	1	90	1	75
Pasture rented	17	348	15	240	13	205
Total charges	....	$5,076	....	$4,098	....	$3,076
Received for pasture	12	198	5	37	3	70
Difference (= cost of pasture)	....	$4,878	....	$4,061	....	$3,006
Credited for horses, colts, and sheep pastured	19	163	20	60	21	131
Difference (= charge to cattle)	....	$4,715	....	$4,001	....	$2,875
Cows' share, based on proportion of equivalent in total animal units pastured for entire season represented by cows pastured	....	$3,665	....	$3,353	....	$2,320

A larger proportion of the calves born in summer dairies are raised, than in herds producing more milk in winter. In winter dairies (the first group), 58 per cent of the calves were vealed or deaconed, in the second group 56 per cent were vealed or deaconed, and in summer herds 52 per cent were vealed or deaconed. In the first group, 35 per cent of the calves born during the year were heifers to be raised at home or elsewhere; in the second group this figure was 38 per cent; and in the third group, largely composed of summer dairies, it was 41 per cent. The raising of more heifer calves from the lower-producing summer dairies operates to keep down the average production of cows in the State.

Practically all of the costs are higher when a larger proportion of the milk is produced in winter. In other words, the system is more intensive thruout, but especially so in regard to feeding.

TABLE 62. COST OF BEDDING USED

Kind of bedding	Less than 33 per cent of milk sold during May, June, and July		From 33 to 40 per cent of milk sold during May, June, and July		More than 40 per cent of milk sold during May, June, and July	
	Number of farms using	Value of bedding	Number of farms using	Value of bedding	Number of farms using	Value of bedding
Home-grown:						
Oat straw	33	$363	35	$526	24	$282
Buckwheat straw	7	33	7	52	8	16
Wheat straw	....	......	....	......	1	2
Rye straw	1	18	....	......	....	......
Chaff	....	......	4	9	2	8
Swamp and marsh hay	2	13	2	9	1	18
Sawdust	3	4	4	16	1	2
Total home-grown	....	$431	....	$612	....	$328
Purchased:						
Sawdust	21	$152	20	$74	10	$49
Shavings	3	12	....	......	2	6
Buckwheat straw	1	2	....	......	....	......
Oat straw	1	2	....	......	1	5
Total purchased	....	$168	....	$74	....	$60
Total bedding	....	$599	....	$686	....	$388

The value of feed, except pasture used in the winter dairies, was $60.44 per cow, and in the summer dairies it was $41.54 per cow. The value of labor was about $3 less per cow in the latter group. The cows were valued at less, and less feed was kept on hand, and so the interest was less. Also, as is discussed later, the cost of keeping herd bulls was less. The distance to the milk stations is greater for the summer dairies, and this, together with the fact that the herds were smaller and the production was less, made the charges for milk hauling higher. The total costs per cow were $117.32, $100.81, and $93.51, respectively, for the three groups.

Not only was the production less in the summer dairies, but, owing to the fact that a large proportion of the milk was sold in the months when the prices were lowest, the average price for the year was 18 cents less than for winter dairies. Hence the differences in the receipts per cow from milk sold were greater than the differences in production.

At the average price of $1.72 per hundredweight, the milk sold from winter dairies amounted to $92.99 per cow; at $1.60, the average price in the middle group, it was $79.22; and at $1.54, the price for summer dairies, it was $74.30.

TABLE 63. CHARGES FOR USE OF BUILDINGS

	Less than 33 per cent of milk sold during May, June, and July				From 33 to 40 per cent of milk sold during May, June, and July				More than 40 per cent of milk sold during May, June, and July			
	Number of farms	Value of buildings at beginning	Number of farms	Value of buildings at end	Number of farms	Value of buildings at beginning	Number of farms	Value of buildings at end	Number of farms	Value of buildings at beginning	Number of farms	Value of buildings at end
Dairy and cattle barns	56	$58,397	56	$57,800	52	$45,384	52	$46,290	41	$23,831	41	$24,487
Silos	27	5,152	31	5,707	19	2,605	19	2,555	8	1,175	10	1,515
Milk houses	43	1,918	43	1,900	42	1,336	44	1,467	37	1,454	37	1,454
Ice houses	33	1,324	34	1,352	33	1,515	33	1,505	28	655	28	650
Total	....	$66,791	....	$66,759	....	$50,840	....	$51,817	....	$27,115	....	$28,106
Average value		$66,775.00				$51,329.00				$27,610.00		
Interest at 5 per cent		3,338.75				2,566.45				1,380.50		
Decrease in value		32.00				....				......		
Insurance		205.00				167.00				83 00		
	Number of farms			Cost of repairs	Number of farms			Cost of repairs	Number of farms			Cost of repairs
Repairs and new buildings:												
Purchased lumber	3			$ 26.50	4			$260.90	..			....
Shingles and roofing	5			108.50	10			444 50	3			$ 12.00
Paint and glass	19			175.70	17			248 00	4			4.00
Hardware	1			0.60	2			113.00	.			....
Materials from farms	9			288.50	6			74.00	2			62.00
Sand and gravel	4			16.75	1			2.00	1			2 50
Cement	4			31.00	3			158.50	2			10.90
Labor:												
Hired	9			391.20	7			526.25	2			25.00
Farm	12			170.16	8			313.50	6			32.50
Horse	3			28.20	2			25.00	2			21.00
Board of labor	4			13.50	1			5.00	1			8.00
New buildings, labor and materials	4			319.60	2			34.90	4			1,557 00
Total	37			$1,570.21	33			$2,205.55	16			$1,734 90
Increase in value		....				$977.00				$991.00		
Total charged to dairy cattle for use of buildings		$5,145.96				$3,962.00				$2,207.40		
Cows' share, based on proportion of average total cattle units on hand represented by cows		$3,915.77				$3,142.71				$1,647.21		

TABLE 64. CHARGES FOR USE OF EQUIPMENT

	Less than 33 per cent of milk sold during May, June, and July				From 33 to 40 per cent of milk sold during May, June, and July				More than 40 per cent of milk sold during May, June, and July			
	Number of farms	Value of equipment at beginning	Number of farms	Value of equipment at end	Number of farms	Value of equipment at beginning	Number of farms	Value of equipment at end	Number of farms	Value of equipment at beginning	Number of farms	Value of equipment at end
Milk cans	46	$435	46	$422	42	$355	43	$347	32	$250	33	$228
Coolers	5	16	5	15	2	5	3	10	3	9	3	9
Testers, bottles, and scales	6	13	7	15	9	24	9	24	2	7	2	7
Separators	8	102	8	100	5	149	5	143	2	60	3	80
Churns and workers	14	39	14	39	15	24	15	24	11	22	11	22
Bottles and containers	2	3	2	3	2	2	2	2	3	6	3	6
Milk wagons	31	553	31	495	28	571	29	615	31	586	32	576
Milking machines	....	....	....	....	....	....	....	....	....	....	1	250
Ice tools	32	107	32	107	32	78	32	77	27	52	27	52
Feed cutters	....	....	....	....	....	....	....	....	1	25	1	25
Pumps and root cutters	4	10	2	6	....	....	....	....	1	3	1	3
Grinders and engines	5	408	8	442	3	345	3	320	2	35	3	32
Milk pails and strainers	56	132	56	133	51	101	52	119	40	81	40	80
Extra calf pails	13	14	14	14	11	11	12	13	7	8	7	7
Clipping machines	9	50	11	64	8	38	10	48	7	27	7	29
Veterinary outfits	8	16	8	16	1	1	2	2	2	4	3	7
Forks, shovels, and other barn tools	52	170	53	178	40	118	36	114	34	72	33	72
Wheelbarrows and trucks	11	32	12	33	17	45	21	55	13	26	14	26
Staffs and halters	12	13	9	13	7	7	11	11	3	3	4	4
Total	56	$2,113	56	$2,095	52	$1,874	52	$1,924	41	$1,276	41	$1,515
Average value		$2,104				$1,899				$1,395		
Interest at 5 per cent		$105.20				$ 94.95				$ 69.75		
Cost of equipment purchased		336.00				335.30				408 00		
Repairs		74.00				94 00				62.00		
Decreased value		18.00				....				......		
Total		$533.20				$524.25				$539.75		
Increase in value		....				$50.00				$239 00		
Total charged to dairy cattle for use of equipment		$533.20				$474.25				$300.75		
Cows' share, determined by apportioning to cows, heifers, and herd bulls the charge for use of equipment on each farm		$414.75				$364.05				$236.30		

TABLE 65. INTEREST CHARGES

	Less than 33 per cent of milk sold during May, June, and July	From 33 to 40 per cent of milk sold during May, June, and July	Over 40 per cent of milk sold during May, June, and July
Interest on cows	$2,657.85	$2,374.00	$1,625.55
Interest on feed and supplies kept on hand for cows	673.50	516.50	321.50

Manure recovered amounted to 7.2 tons per cow in summer dairies, and 8.2 tons per cow in winter dairies, a difference of 1 ton per cow.

The total returns per cow for the three groups were $112.85, $98.45, and $92.65, respectively. The apparent losses per cow were $4.47, $2.36, and $0.86.

TABLE 66. DEPRECIATION ON COWS

	Less than 33 per cent of milk sold during May, June, and July			From 33 to 40 per cent of milk sold during May, June, and July			More than 40 per cent of milk sold during May, June, and July		
	Number of farms	Number of stock	Value of stock	Number of farms	Number of stock	Value of stock	Number of farms	Number of stock	Value of stock
Cows purchased	17	53	$3,883	18	57	$3,382	12	24	$1,355
Heifers that became cows	44	158	9,060	31	88	4,757	28	58	3,400
Total value	.....	.....	$12,943	.....	.....	$8,139	.....	.....	$4,755
Cows slaughtered or sold for slaughter	37	90	$3,633	30	79	$2,927	19	39	$1,449
Cows sold for breeding or production	15	44	2,530	14	33	1,650	13	40	2,190
Total value	.....	.....	$6,163	.....	.....	$4,577	.....	.....	$3,639
Cow hides sold	13	18	$ 120	15	21	$ 229	10	11	$ 81
Increase in inventory of cows	.....	60	4,514	.....	8	927	.....	.....	.....
Decrease in inventory of cows	.....	.....	.....	.....	.....	.....	.....	10	135
Cows purchased and heifers that became cows, plus decrease in inventory of cows, less value of cows slaughtered or sold, less sales of cow hides, less increase in inventory of cows (= depreciation on cows)	.....	.....	$2,146	.....	.....	$2,406	.....	.....	$1,170
Calves born during year, and value at birth:									
Heifers to be raised or sold	50	269	$825	51	271	$818	39	193	$589
Bulls to be kept	18	19	70	15	17	68	17	18	88
Bulls sold or to be sold	20	33	149	12	28	116	10	14	46
Calves vealed or to be vealed	51	378	705	49	363	654	37	196	291
Calves deaconed	19	73	.....	14	39	.....	18	50	.....
Deacon hides and carcasses	18	69	68	14	39	48	18	50	53
Total calves born alive	55	772	$1,817	51	718	$1,704	41	471	$1,067
Calves born dead	12	19	.....	16	25	.....	7	9	.....
Calf hides and carcasses	4	6	8	6	12	9	3	3	3
Cows that aborted	11	19	.....	7	13	.....	7	9	.....
Total credited	.....	.....	$1,825	.....	.....	$1,713	.....	.....	$1,070
Difference (= cow decrease)	.....	.....	$321	.....	.....	$693	.....	.....	$100

Since so many of the costs are less, the cost of producing milk or butterfat is much less, when chiefly summer milk is made. But the price also

is less, and therefore the gain is not proportional to the decrease in cost of production. When the herd cost is considered, the loss per hundred pounds of milk sold was 12 cents for winter dairies, 5 cents for the mixed summer and winter dairies, and nothing for the summer dairies. When the cow cost is considered, the loss was 9 cents, 5 cents, and 2 cents, respectively. A gain on heifers in summer dairies, and a loss on heifers in winter dairies, caused the herd cost of milk to decrease faster than the cow cost. The herd cost of milk per hundred pounds was 30 cents, and the cow cost 25 cents, higher in the winter dairies than in the summer dairies.

TABLE 67. RELATION OF SEASON OF PRODUCTION TO PROPORTION OF COWS REPLACED EACH YEAR

	Less than 33 per cent of milk sold during May, June, and July		From 33 to 40 per cent of milk sold during May, June, and July		More than 40 per cent of milk sold during May, June, and July	
	Total number	Per 100 cows	Total number	Per 100 cows	Total number	Per 100 cows
Cows purchased	53	6.6	57	7.6	24	4.8
Heifers that became cows	158	19.8	88	11.6	58	11.5
Total	211	26.4	145	19.2	82	16.3
Increase in inventory	60	......	8	......	......	......
Decrease in inventory	......	......	......	......	10	......
Difference	151	18.9	137	18.1	92	18.3
Cows slaughtered or sold for slaughter	90	11.3	79	10.4	39	7.8
Cows sold for production	44	5.5	33	4.4	40	7.9
Number that died	17	2.1	25	3.3	13	2.6

TABLE 68. MISCELLANEOUS COSTS

	Less than 33 per cent of milk sold during May, June, and July		From 33 to 40 per cent of milk sold during May, June, and July		More than 40 per cent of milk sold during May, June, and July	
	Number of farms	Value of item	Number of farms	Value of item	Number of farms	Value of item
Ice	38	$620	38	$662	32	$429
Veterinary fees	17	138	20	110	13	79
Medicines, disinfectants, and louse killers	30	94	31	89	21	52
Fly protectors	41	84	38	102	28	73
Whitewashing	34	132	39	107	32	68
Milk testing, acids, etc	8	124	5	64	3	60
Insurance on cows	42	68	35	50	27	44
Feed grinding and freight	8	19	11	46	7	16
Express on cattle	1	1	1	1	......	......
Sawdust for ice	7	16	5	17	7	20
Hauling feed	1	6	1	6	1	2
Hauling bedding	1	5	1	10	......	......
Gasoline, oil, and batteries	1	8	1	13	1	7
Fuel for water heater	2	11	......	......	......	......
Clipping	5	8	3	3	4	5
Lime	1	1	......	......	......	......
Board of cows	1	26	......	......	......	......
Total	......	$1,361	......	$1,280	......	$855

TABLE 69. QUANTITY AND VALUE OF MILK SOLD

	Less than 33 per cent of milk sold during May, June, and July			From 33 to 40 per cent of milk sold during May, June, and July			More than 40 per cent of milk sold during May, June, and July		
	Number of farms	Number of pounds	Value	Number of farms	Number of pounds	Value	Number of farms	Number of pounds	Value
May	56	442,176	$5,897.44	52	473,701	$5,947.04	41	347,634	$4,331.72
June	56	420,026	5,188.26	52	484,969	5,783.80	41	372,926	4,455.47
July	56	305,332	4,195.75	52	404,604	5,486.65	41	321,283	4,356.40
August	55	232,755	3,692 86	52	314,796	4,848.89	41	256,984	3,926.38
September	56	235,202	4,108 61	52	279,046	4,664.40	41	215,163	3,549.49
October	56	309,041	6,122.15	52	262,971	5,123.38	41	185,925	3,613.30
November	56	326,953	6,772.02	52	223,126	4,559.12	41	128,209	2,624.05
December	56	386,512	8,040.87	51	221,417	4,510.97	40	102,891	2,116.73
January	56	409,469	8,256.67	51	236,051	4,635.43	35	90,334	1,800.98
February	56	371,416	7,101.62	52	225,219	4,147.84	32	78,206	1,451.48
March	56	410,659	7,473.24	51	281,119	5,040.30	33	121,972	2,159.88
April	56	411,364	6,380.90	52	320,370	4,749.27	38	192,607	2,811.42
Retail	25	41,920	973.90	15	21,074	475.46	13	7,804	178.08
Total	......	4,302,825	$74,204.29	......	3,748,463	$59,972.55	......	2,421,938	$37,375.38

TABLE 70. PROPORTION OF MONTHLY MILK PRODUCTION BY SEASONAL GROUPS

	Less than 33 per cent of milk sold during May, June, and July	From 33 to 40 per cent of milk sold during May, June, and July	More than 40 per cent of milk sold during May, June, and July
	Per cent of pounds of milk sold for month		
May	35.0	37.5	27.5
June	32.9	37.9	29.2
July	29.6	39.3	31.1
August	29.0	39.1	31.9
September	32.2	38.3	29.5
October	40.8	34.7	24.5
November	48.2	32.9	18.9
December	54.4	31.1	14.5
January	55.6	32.1	12.3
February	55.1	33.3	11.6
March	50.5	34.5	15.0
April	44.4	34.7	20.9
Per cent of total milk sold for year	41.1	35.8	23.1
Per cent of total number of cows	38.8	36.8	24.4
Per cent of total number of farms	37.6	34.9	27.5

TABLE 71. QUANTITY AND VALUE OF MILK AND ITS PRODUCTS USED ON FARMS, AND OF MILK PRODUCTS SOLD

	Less than 33 per cent of milk sold during May, June, and July			From 33 to 40 per cent of milk sold during May, June, and July			More than 40 per cent of milk sold during May, June, and July		
	Number of farms	Number of pounds	Value	Number of farms	Number of pounds	Value	Number of farms	Number of pounds	Value
Milk used:									
Family	54	116,315	$2,002.97	52	119,661	$1,909.26	41	77,072	$1,191.10
Hired man	8	10,085	180.53	5	7,165	117.50	1	388	6.13
Heifers	50	92,009	1,561.61	50	81,603	1,306.89	34	41,852	649.27
Veals and bulls to be sold	34	67,761	1,152.40	34	74,622	1,197.78	26	51,152	776.73
Bull calves to be kept for herd bulls	24	10,497	181.65	21	8,299	132.70	20	7,479	115.12
Milk products used:									
Skimmilk:									
Hogs	2	8,000	13.20	4	16,100	34.15	4	6,600	12.62
Poultry	1	2,200	3.30	......	......	....	.....	....	....
Heifers	11	31,450	49.03	10	36,120	67.37	11	28,498	54.77
Veals and bulls to be sold	......	.....	....	......	......	....	4	3,072	6.16
Bull calves to be kept for herd bulls	1	2,000	3.00	3	1,780	3.56	4	2,713	4.52
Buttermilk:									
Family use	6	2,100	4.60	10	3,514	7.20	5	1,650	4.13
Hogs	1	500	1.00	3	750	2.01	6	2,000	4.49
Poultry	......	.....	....	1	100	0.20	.....	....	....
Heifers	2	1,000	1.70	......	......	....	1	300	0.75
Butter, family use	13	1,864	556.95	12	2,380	675.60	11	1,412	401.42
Cream, family use	2	200	30.00	5	556	101.84	4	244	48.80
Total milk and its products used on farms	.....	......	$5,741.94	......	......	$5,556.06	.....	....	$3,276.01
Milk products sold:									
Butter	2	218	$64.69	......	......	....	5	797	$248.07
Cream	1	200	30.00	......	......	....	.....	....	....
Total milk products sold	.....	......	$94.69	......	......	....	.....	....	$248.07

TABLE 72. MANURE RECOVERED AND MISCELLANEOUS RETURNS

	Less than 33 per cent of milk sold during May, June, and July		From 33 to 40 per cent of milk sold during May, June, and July		More than 40 per cent of milk sold during May, June, and July	
	Number of tons	Value	Number of tons	Value	Number of tons	Value
Manure recovered	6,527	$8,158.52	5,764	$7,204.52	3,626	$4,533.60
Miscellaneous returns:						
Boarding cows	......	28.00	......	....	......	24.00
Hauling milk	......	....	......	84.00	......	73.00

TABLE 73. COSTS AND RETURNS FOR COWS BY SEASONAL GROUPS

	Less than 33 per cent of milk sold during May, June, and July		From 33 to 40 per cent of milk sold during May, June, and July		More than 40 per cent of milk sold during May, June, and July	
	Total value	Value per cow	Total value	Value per cow	Total value	Value per cow
Costs:						
Grain, summer	$ 1,442.00	$ 1.81	$ 1,545.00	$ 2.04	$ 1,038.00	$ 2.06
Grain, winter	17,977.00	22.53	13,268.00	17.53	7,588.00	15.09
Succulent feed	12,261.00	15.36	7,962.00	10.52	2,289.00	4.55
Dry forage	16,549 00	20.74	14,191.00	18.74	9,982.00	19.84
Total feed	....	$ 60.44	....	$ 48.83	....	$41.54
Pasture	$ 3,665.00	$ 4.59	$ 3,353.00	$ 4.43	$ 2,320.00	$ 4.61
Bedding	599.00	0.75	689.00	0.91	385.00	0 77
Human labor	21,086.20	26.43	16,724.70	22.09	11,597.10	23.05
Horse labor	789.00	0.99	543.15	0.72	359.70	0.72
Hauling milk	6,977.75	8.75	7,420.28	9.80	5,286.76	10.51
Use of buildings	3,915.77	4.91	3,142.71	4.15	1,647.21	3.27
Use of equipment	414 75	0.52	364.05	0.48	236.30	0.47
Interest on cows	2,657.85	3.33	2,374 00	3.14	1,625.55	3.23
Interest on feed and supplies	673.50	0 84	516.50	0.68	321.50	0.64
Depreciation on cows	2,146.00	2.69	2,406.00	3.18	1,170.00	2.33
Bull service	1,102.30	1.38	533.78	0.71	335.22	0.67
Miscellaneous	1,361.00	1.70	1,280.00	1.69	855.00	1.70
Total costs	$93,617.12	$117 32	$76,313.17	$100.81	$47,036 34	$93.51
Returns:						
Milk sold	$74,204.29	$ 92 99	$59,972.55	$ 79.22	$37,375.38	$74.30
Milk products sold	94.69	0.12	....	....	248.07	0.49
Milk and milk products used	5,741.94	7.20	5,556.06	7.34	3,276.01	6.51
Calves and calf hides	1,825.00	2.29	1,713.00	2.26	1,070.00	2.13
Manure	8,158.52	10.22	7,204.52	9.52	4,533.60	9.03
Miscellaneous returns	28.00	0.03	84.00	0.11	97.00	0.19
Total returns	$90,052.44	$112.85	$74,530.13	$ 98.45	$46,600.06	$92.65
Loss	$3,564.68	$4 47	$1,783.04	$2.36	$436.28	$0.86

TABLE 74. RELATION OF SEASON OF PRODUCTION TO COST OF PRODUCTION AND AVERAGE PRICE OF PRODUCT

	Less than 33 per cent of milk sold during May, June, and July		From 33 to 40 per cent of milk sold during May, June, and July		More than 40 per cent of milk sold during May, June, and July	
	Herd cost	Cow cost	Herd cost	Cow cost	Herd cost	Cow cost
Cost per hundred pounds of milk sold	$1.84	$1.81	$1.65	$1.65	$1.54	$1.56
Per cent of cost (first group taken as 100)	100	100	90	91	84	86
Cost per pound of butterfat in milk sold	$0.460	$0 452	$0.412	$0.412	$0.376	$0.380
Amount received per hundred pounds of milk sold	$1.72		$1.60		$1.54	

Summer and winter seasons in winter dairies

In dairies producing about equal amounts of milk in summer and in winter, the cost of milk in winter was double the cost in summer. Manure and calves in winter offset all costs except for feed, for hauling milk, and for human labor. The data are given in table 75.

Conclusions regarding season of production

While the results of this study indicate that at the prices for milk, feed, labor, and other things used in milk production, the herds producing a

larger proportion of milk in summer were slightly more profitable than the winter herds, it must be remembered that changes in winter prices for milk or feed might change these relationships. For this reason it is not to be understood that in other regions, or even at times of different prices in this region, the more extensive systems of dairying are the more profitable.

TABLE 75. COSTS AND RETURNS (EXCEPT MILK) FOR PASTURE AND WINTER PERIODS, 56 FARMS, 798 COWS, WINTER DAIRIES

	Less than 33 per cent of milk sold during May, June, and July			
	Pasture period		Winter period	
	Total	Per 100 pounds of milk	Total	Per 100 pounds of milk
Costs:*				
Grain	$1,442.00	$0.081	$17,977.00	$0.628
Silage	294.00	0.016	10,865.00	0.380
Other succulent feed	586.00	0.033	516.00	0.018
Dry forage	35.00	0.002	16,514.00	0.577
Pasture	3,665.00	0.205	....	....
Total feed	$6,022.00	$0.337	$45,872.00	$1.603
Bedding	......	....	599.00	0.021
Human labor	6,550.10	0.367	14,536.10	0.508
Horse labor	......	....	789.00	0.028
Hauling milk	2,679.59	0.150	4,298.16	0.150
Use of buildings	1,695.05	0.095	2,220.72	0.078
Use of equipment	179.54	0.010	235.21	0.008
Interest on cows	1,150.52	0.064	1,507.33	0.053
Interest on feed and supplies	....	....	673 50	0.023
Bull service	477.16	0.028	625.14	0.022
Depreciation on cows	928.96	0.052	1,217.04	0.042
Ice, and sawdust for ice	636.00	0.036	....	....
Fly protectors	84.00	0.005	....	....
Other miscellaneous costs	277.47	0.015	363 53	0.013
Total costs	$20,680.39	$1.159	$72,936.73	$2.549
Returns, except milk:				
Calves and calf hides	$790.00	$0.044	$1,035.00	....
Manure	....	....	8,158.52	....
Boarding cows	....	....	28.00	....
Total returns, except milk	$790.00	$0.044	$9,221.52	$0.322
Difference (= cost of milk produced)	$19,890.39	$1.115	$63,715.21	$2.227

* The costs for hauling milk were divided according to the amount of milk produced in the pasture and in the winter period; all other costs were divided according to the length of the period — 158 days pasture, 207 days winter.

Another factor to be considered is that the aim of a well-organized farm business should be to furnish productive work thruout the year. From the farm-management point of view, the dairy enterprise must be considered in its relation to the farm business as a whole. Presumably, on many farms where dairying is the leading part of the business, the more extensive system does not furnish full employment, especially during the winter season. Such a system might pay good wages for the hours employed, while an intensive system, altho paying less by the hour, might provide a fuller year's work, and hence a larger total income.

Feeds and feeding

Details concerning the kinds, the total amounts, and the costs of various feeds used by cows, per cow and per unit of product, have already been given.

Nutriment and energy

Many careful investigations concerning the nutrient requirements of dairy cows for milk production have been carried on with single animals or with experiment-station herds. These studies have helped to establish useful standards and guides for the feeding of dairy cattle, and for this reason have been of economic value to farmers. The records obtained in the present investigation offered an opportunity to study the dry matter, digestible nutrients, digestible crude protein, digestible carbohydrates, feed units, and net energy used under farm conditions, in relation to the requirements for maintenance and milk production set by the various feeding standards, and also to note the effect of various factors such as season of milk production and composition of the ration on the nutriment or the energy used per unit of product.

Certain terms are defined in more than one way in literature on feeding, and therefore the following definitions are given in order to insure better understanding of the discussion.

The sum of the digestible crude protein, the digestible carbohydrates, and 2.25 times the digestible fat, is called the *total digestible nutrients*. The term *total nutriment* is often used to mean total digestible nutrients.

A *feed unit* is that amount of any feed which, when consumed by an animal, will produce the same amount of milk, flesh, or energy that is produced by a pound of corn.

The energy of feed is expended by the dairy cow in muscular activity, maintenance, growth, and milk production. The production value of a feeding stuff, therefore, depends very largely on the amount of energy it will yield. A convenient unit for measuring this energy is the *therm*, which is 1000 Calories, or the amount of heat required to raise 1000 kilograms of water one degree centigrade.

Not all of the energy in a feed is available for use by the animal. Some of it is lost in the undigested parts of the feed. Some of it is lost in the combustible gases arising from fermentations in the intestines and the paunch. Some of it passes out in the urea. The fuel value of any feed which remains after deducting these three losses represents the available energy, or *metabolizable energy*, of the feed. It is that part of the energy in the feedstuff which the animal can use for body or production purposes.

But much of the available, or metabolizable, energy is spent in the work of mastication, digestion, and assimilation. That part which remains after deducting the amount used in these ways is termed the *net energy* of the feed. This is the part of the energy available for body maintenance

and for production. All energy computations in this bulletin are on the net energy basis.

Method of computing nutriment and energy.— The feeds used were divided into four classes: (1) grain, which included all concentrated feeding stuffs whether home-grown or purchased; (2) silage; (3) other succulent feed, which included feeds with a very high percentage of water; and (4) dry forage, which included hay, corn stover, and other cured roughage.

The nutrients in most of the feeds used were computed from tables in *Feeds and Feeding* (fifteenth edition), by Henry and Morrison. The digestible composition of feeds not given in these tables was calculated by applying digestion coefficients there given to analysis figures reported in Bulletin 3, Control Series, of the Massachusetts Agricultural Experiment Station. When the digestion coefficient for a particular feed was not given, the coefficient for a feed similar in character was used.

The feed-unit values assigned the different feeds were taken from Research Bulletin 26 of the Wisconsin Agricultural Experiment Station, and from *Feeds and Feeding* as already cited.

The therms in the feeds were calculated from net energy values in Bulletin 142 of the Pennsylvania Agricultural Experiment Station, or from net energy values computed by use of the formula given on pages 8 and 9 of that bulletin.

Feed, nutriment, and energy used per cow per day, supplementary to pasture.— In table 76 are given the average daily amounts of feed used supplementary to pasture, and the nutriment and net energy contained in the feed. The usual practice on these farms was to feed some grain and green corn or other succulent feed late in summer, when pastures dried up. In only ten cases, however, was silage used for this purpose. As a rule, summer production is made chiefly on grass. The therms in the feed used supplementary to pasture were equivalent to about 13 days of winter feeding. On this basis, pasture furnished 146 days, or nearly five months, of full feed for cows. This is less than on the dry-matter basis. The average nutritive ratio of feeds used with pasture was 1:5.1.

Feed, nutriment, and energy used per cow per day during the winter period.— On the average, 6.007 pounds of grain, 18.110 pounds of silage, 1.471 pounds of other succulent feed, and 20.141 pounds of dry forage, were used per cow per day in winter. This ration contained 26.912 pounds of dry matter, 16.446 pounds of digestible nutrients, 2.034 pounds of crude protein, and 13.166 pounds of digestible carbohydrates, with an energy value of 14.551 therms and representing 16.810 feed units. The average nutritive ratio was 1:7.1. Grain furnished 29.7 per cent, succulent feed 15.9 per cent, and dry forage 54.4 per cent, of the net energy value of the ration. (Table 77).

The summer dairies fed less in winter than did the winter dairies. The difference was about four pounds of digestible nutrients, or 3.8 therms,

TABLE 76. AVERAGE AMOUNTS OF FEED USED PER COW PER DAY, SUPPLEMENTARY TO PASTURE, 159 DAYS, 2058 COWS

	Pounds of feed	Dry matter		Digestible nutrients		Digestible crude protein		Digestible carbohydrates		Feed units		Net energy		Cost*
		Pounds	Per cent	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent	Number of units	Per cent	Therms	Per cent	
Grain	0.856	0.779	46.0	0.634	51.5	0.152	75 6	0.399	43.8	0.874	62 7	0.602	51 1	$0 0123
Silage	0 471	0.099	5 8	0.063	5.1	0.005	2.5	0.054	5 0	0.078	5.6	0.056	4 8	0.0012
Other succulent feed	3.359	0.744	43.9	0 495	40.2	0.041	20.4	0.424	46 6	0.413	29 6	0 489	41 5	0.0049
Dry forage	0.084	0.072	4.3	0.040	3.2	0.003	1.5	0 034	3.7	0.030	2.1	0 031	2 6	0.0003
Total	4.770	1.694	100.0	1.232	100.0	0 201	100.0	0.911	100 0	1.395	100.0	1.178	100 0	$0.0187

1.232 (pounds digestible nutrients) − 0.201 (pounds crude protein) = 1.031.
1.031 ÷ 0.201 = 5.1.
Nutritive ratio, 1:5.1.

* Omitting condimental feed and salt.

TABLE 77. AVERAGE AMOUNTS OF FEED USED PER COW PER DAY IN THE WINTER PERIOD, 206 DAYS, 2058 COWS

	Pounds of feed	Dry matter		Digestible nutrients		Digestible crude protein		Digestible carbohydrates		Feed units		Net energy		Cost*	Nutritive ratio
		Pounds	Per cent	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent	Number of units	Per cent	Therms	Per cent		
Grain	6.007	5.442	20.2	4 447	27.1	1.050	51 6	2.825	21.5	6.177	36.8	4.319	29.7	$0.0900	1:3.2
Silage	18.110	3.813	14.2	2.414	14.7	0.182	9 0	2.068	15.7	3.015	17.9	2.164	14.9	0.0452	1:12.3
Other succulent feed	1.471	0.204	0.8	0.154	0.9	0.018	0.9	0.131	1.0	0.155	0.9	0.146	1.0	0.0032	1:7.6
Dry forage	20.141	17.453	64.8	9.431	57.3	0.784	38.5	8.142	61.8	7.463	44.4	7.922	54.4	0.0958	1:11.0
Total	45.729	26.912	100.0	16.446	100.0	2 034	100.0	13.166	100.0	16.810	100.0	14.551	100 0	$0.2342	1:7.1

16.446 (pounds digestible nutrients) − 2.034 (pounds crude protein) = 14.412.
14.412 ÷ 2.034 = 7.1.
Nutritive ratio, 1:7.1.

* Omitting condimental feed and salt.

TABLE 78. Relation of Season of Milk Production to Average Amounts of Feed Used per Cow per Day in the Winter Period

	Pounds	Dry matter (pounds)	Digestible nutrients		Digestible crude protein		Digestible carbohydrates (pounds)	Feed units	Net energy		Cost*	Nutritive ratio
			Pounds	Per cent	Pounds	Per cent			Therms	Per cent		
Less than 33 per cent of milk sold during May, June, and July, 56 farms, 798 cows, 207 days												
Grain	7.222	6.554	5.336	28.6	1 317	54.0	3 294	7.469	5.188	31.3	$0.1073	1:3.05
Silage	26.306	5.524	3.499	18.7	0.263	10.8	2.999	4.380	3.144	18.9	0.0658	1:12.3
Other succulent feed	1.766	0.233	0.174	0.9	0.023	1.0	0.145	0.175	0.164	1.0	0.0031	1:6.6
Dry forage	20.536	17.820	9.663	51.8	0.835	34.2	8.301	7.689	8.091	48 8	0.1000	1:10.6
Total	55.830	30.131	18.672	100.0	2.438	100.0	14.739	19.713	16.587	100.0	$0.2762	1:6.7
From 33 to 40 per cent of milk sold during May, June, and July, 52 farms, 757 cows, 205 days												
Grain	5.568	5.036	4.120	26.8	0.937	50.7	2 674	5.694	4.003	29.4	$0.0836	1:3.40
Silage	17.365	3.674	2.323	15.1	0.175	9.5	1.990	2.891	2.075	15.2	0.0432	1:12.3
Other succulent feed	1.433	0.177	0.137	0.9	0.015	0.8	0.117	0.143	0.127	0.9	0.0034	1:8.1
Dry forage	18.821	16.301	8.784	57.2	0.722	39.0	7.595	6.952	7.429	54.5	0.0911	1:11.2
Total	43.187	25.188	15.364	100.0	1.849	100.0	12.376	15.680	13.634	100.0	$0.2213	1: 7.3
More than 40 per cent of milk sold during May, June, and July, 41 farms, 503 cows, 204 days												
Grain	4.773	4.318	3.554	24.3	0.803	47.8	2.326	4 886	3.437	26.8	$0.0727	1:3.43
Silage	6.215	1.305	0.827	5.6	0.062	3.7	0.708	1.035	0.743	5.8	0.0155	1:12.3
Other succulent feed	1.068	0.198	0.148	1.0	0.014	0.8	0.128	0.140	0.148	1.2	0.0032	1:9.6
Dry forage	21.689	18.766	10.125	69.1	0.803	47.7	8.791	7.942	8.471	66.2	0.0971	1:11.6
Total	33.745	24.587	14.654	100.0	1.682	100.0	11.953	14.003	12.799	100.0	$0.1885	1:7.7

*Omitting condimental feed and salt.

per cow per day. Also, less silage and a poorer quality of roughage were used in summer dairies, and the ration was wider, being 1:7.7 in summer dairies and 1:6.7 in winter dairies. In the summer dairies, grain furnished 27 per cent of the energy. On farms where more winter milk was made, grain furnished more of the energy, and roughage, especially dry forage, furnished less. This, together with less silage and poorer hay, accounts for the difference in nutritive ratio. (Table 78.)

Rations compared with feeding standards.— The average weight of the cows was not ascertained, but in order to make comparisons with feeding standards it was assumed to be 1000 pounds. The average daily production in the winter period of 206 days from October 9 to May 14 for the 2058 cows was 14.037 pounds of 4-per-cent milk. In the pasture period it was 16.609 pounds of 4-per-cent milk.

It would not be expected that the feed used by the cows on these farms would check exactly with requirements according to feeding standards for 1000-pound cows with this production, for the following reasons:

1. Probably feeding standards have been determined with higher producers and possibly more efficient users of feed than the cows in question.

2. Probably feeding standards have been based on fresh cows or cows near the beginning of their lactation. On the other hand, many of the cows in question were finishing their lactation during winter. More nutriment is required for production at the end of a lactation period than at the beginning.

3. Probably the roughage used on these farms was of poorer quality than that on which standards are based. Also some of this was waste from the mangers used as bedding, and for this there has been no deduction from the dry forage.

4. It is likely that feeding standards have been arrived at with rations carrying a larger proportion of concentrates, and especially succulent feed, than the rations here used.

5. It is possible that the nutrient and energy values applied to the feeds used, particularly to the roughages, may have exceeded their actual values.

6. Probably animals used in feeding-standard experiments were more nearly of the age of maximum production efficiency and in better average condition than the herds studied. Of the 2058 cows included, some were heifers with the first calf, some were old cows, some were animals out of condition because of calving difficulties, and some were cows that had failed to breed. In choosing cows for feeding trials, probably such cows are eliminated, but dairymen are always confronted with the problem of carrying a considerable proportion of such animals.

7. One would presume that the feeding, watering, care, and stabling conditions of animals on experimental trials would favor more efficient use of feeds than is practicable on the ordinary farm.

8. There is a possibility that the assumed weight of the cows may have been less than their actual weight.

TABLE 79. RATIONS COMPARED WITH THE DAILY REQUIREMENTS FOR MAINTENANCE AND MILK PRODUCTION ACCORDING TO VARIOUS FEEDING STANDARDS, 2058 COWS.

	Feed units, Hansson	Dry matter (in pounds), Woll-Humphrey	Digestible nutrients (in pounds)				Digestible crude protein (in pounds)					Net energy (in therms)	
			Modified Wolff-Lehmann	Haecker	Woll-Humphrey	Savage	Hansson	Modified Wolff-Lehmann	Haecker	Woll-Humphrey	Savage	Armsby	Eckles
Maintenance, 1000-pound cow	6 6	12.5	7.925	7.925	7.900	7 925	0 650	0.700	0.700	0.700	0.700	6 000	6.000
Pasture period:													
Production (16.609 pounds of 4-per-cent milk)	5.5	18.7	5.747	5.697	12 300	5 813	0.789	0.988	0 897	1.490	1.080	4 484	4.983
Total required	12.1	31.2	13.672	13 622	20 200	13 738	1.439	1.688	1 597	2 190	1 780	10 484	10.983
Amount in supplementary feed	1.4	1 7	1 232	1.232	1 232	1 232	0.201	0 201	0 201	0.201	0 201	1.178	1.178
Amount furnished by pasture on standard basis	10 7	29.5	12.440	12.390	18.968	12 506	1 238	1.487	1.396	1.989	1 579	9.306	9 805
Winter period:													
Production (14.037 pounds of 4-per-cent milk)	4.6	18.7	4.857	4.815	12.300	4 913	0.667	0 835	0.758	1.490	0 912	3.790	4 211
Total required	11.2	31.2	12.782	12.740	20.200	12.838	1 317	1.535	1.458	2.190	1 612	9.790	10.211
Total used	16.8	26.9	16.446	16.446	16.446	16.446	2.034	2.034	2.034	2.034	2.034	14.551	14.551
Amount used in excess of (or below) standard	5 6	—4.3	3 664	3.706	—3.754	3.608	0.717	0.499	0 576	—0.156	0 422	4 761	4.340
Per cent of deviation from standard	+50.0	—13 8	+28.7	+29 1	—18.6	+28.1	+54 4	+32.5	+39 5	—7.1	+26 2	+32.7	+29.8

The actuality of any one or all of these suppositions would make what appears in table 79 to be an excess over standard requirements from one-fourth to one-third, really too high. It is probable that if proper allowance could be made for all of these points, the nutriment and net energy used would check very closely with the standards, all of which, of those proposed lately, agree very closely.

Nutriment and energy used per unit of product.— For each hundred pounds of milk produced in winter there were contained, in the winter feed, 191.72 pounds of dry matter, 117.17 pounds of digestible nutrients, 14.49 pounds of digestible crude protein, and 93.8 pounds of digestible carbohydrates. This feed represented 119.76 feed units and contained 103.67 therms of energy (Table 80). Since the milk tested 4 per cent, one-fourth of these respective quantities was used per pound of butterfat.

TABLE 80. NUTRIMENT, EXCEPT PASTURE, USED PER UNIT OF PRODUCT

	Per 100 pounds of milk produced			Per pound of butterfat produced		
	Pasture period (excluding pasture)	Winter period	Year	Pasture period (excluding pasture)	Winter period	Year
	Less than 33 per cent of milk sold during May, June, and July, 56 farms, 798 cows					
Dry matter (pounds)	12.32	173.93	111.87	3.08	43.44	27 94
Digestible nutrients (pounds)	8.81	107.78	69.78	2.20	26.92	17 43
Digestible crude protein (pounds)	1.48	14.07	9.24	0.37	3.51	2.31
Digestible carbohydrates (pounds)	6.40	85.08	57.02	1.60	21.25	13.71
Feed units	10.23	113.80	74.02	2.56	28.42	18.49
Therms	8.25	95.75	62.16	2.06	23.91	15.53
	From 33 to 40 per cent of milk sold during May, June, and July, 52 farms, 757 cows					
Dry matter (pounds)	10.18	193 02	100.56	2.54	48.25	25.14
Digestible nutrients (pounds)	7.40	117.74	61.94	1.85	29.43	15.48
Digestible crude protein (pounds)	1.22	14 17	7.62	0.31	3.54	1.91
Digestible carbohydrates (pounds)	5.50	94.85	49.66	1.38	23.71	12.41
Feed units	8.24	120.16	63.56	2.06	30.04	15.89
Therms	7.19	104.48	55.28	1.80	26.11	13.82
	More than 40 per cent of milk sold during May, June, and July, 41 farms, 503 cows					
Dry matter (pounds)	7.82	237.07	100.12	1.92	58.46	24.64
Digestible nutrients (pounds)	5.88	141.30	60.40	1.45	34.84	14.86
Digestible crude protein (pounds)	0.88	16.21	7.05	0.22	4.00	1.74
Digestible carbohydrates (pounds)	4.43	115.25	49.05	1.09	28.42	12.07
Feed units	6.56	135.02	58.28	1.61	33.29	14.34
Therms	5.65	123.41	53.07	1.39	30.43	13.06
	All herds					
Dry matter (pounds)	10.20	191.72	105.07	2.54	47.79	26.16
Digestible nutrients (pounds)	7.42	117.17	64.78	1.85	29.20	16.13
Digestible crude protein (pounds)	1.21	14.49	8.15	0.30	3.61	2.03
Digestible carbohydrates (pounds)	5.48	93.80	51.64	1.36	23.37	12.86
Feed units	8.40	119.76	66.61	2.09	29.85	16.59
Therms	7.09	103.67	57.57	1.76	25.84	14.33

In winter dairies, more of the cows freshen in the fall and are at the beginning of their lactation during winter. Thus they make more efficient use of barn feed than do cows in summer dairies, requiring very much less nutriment or energy per unit of product in winter. But the summer dairies get such a large proportion of their production on grass, that when the total year's product is divided into the barn feed, the nutriment and energy factors are less than for winter dairies. From this it is apparent that in studying the relation of any variation in feeding practice to production, nutriment or energy used per unit of product, cost of production, or profits, this factor of season of production must first be considered.

Production in the 159 pasture days was 2641 pounds per cow. Assuming that the energy requirements for maintenance and production during the pasture period are the same as in winter, the pasture production would require 2738 therms per cow. Of this, 187 therms were furnished by supplementary feed, leaving 2550 therms furnished by pasture. This is 16.040 therms per cow per day, or about one therm per pound of milk produced. This averages 5.174 therms per cow per day for each acre pastured. The data are given in table 81:

TABLE 81. NUTRIMENT AND ENERGY FURNISHED BY PASTURE ON BASIS OF NUTRIMENT AND ENERGY IN WINTER FEED PER UNIT OF PRODUCT

	Digestible nutrients (pounds)	Digestible crude protein (pounds)	Digestible carbohydrates (pounds)	Feed units	Therms
Per 1000-pound cow per day	18.228	2 206	14.668	18.496	16.040
Per cow per acre per day	5.88	0.712	4.732	5.966	5.174

In addition to the requirements for maintenance according to Savage's standard, there were used 60.71 pounds of total digestible nutrients, containing 9.5 pounds of digestible crude protein, for each hundred pounds of milk produced in the winter period (table 82). The energy furnished amounted to 60.92 therms per hundred pounds of milk produced in winter,

TABLE 82. NUTRIMENT USED BY 2058 COWS, LESS REQUIREMENTS FOR MAINTENANCE, WINTER PERIOD *

	Per hundred pounds of milk produced	Per pound of butterfat produced
Digestible nutrients (pounds)	60.71	15.13
Digestible crude protein (pounds)	9.50	2.37
Net energy (therms)	60.92	15.18

* The maintenance deducted in calculating the digestible nutrients and crude protein is the standard given by Savage, and the maintenance deducted in calculating net energy is the standard given by Armsby.

in addition to maintenance requirements. Under these circumstances a pound of digestible nutrients, on the average, had a value for milk-production purposes equal to a therm of energy. There is, of course, variation with different feeds in their relative nutriment and net energy values.

Proportion of nutriment and energy used in winter period returned in milk. — Considering that 100 pounds of 4-per-cent milk contains 17.9 pounds of digestible nutrients, 3.3 pounds of digestible protein, and 29.01 therms, then 15.3 per cent of the digestible nutrients, 22.8 per cent of the digestible crude protein, and 28 per cent of the net energy in the winter feed, were contained in the milk produced in winter.

Use of concentrates

Dairymen on these farms are using chiefly high-grade concentrated feeds. The percentage that each feed represents of the total pounds of concentrates used by cows, excluding salt and condimental feeds, is given in table 1 (page 280). Gluten made up 38 per cent, and wheat by-products 21 per cent, making 59 per cent of the total. Molasses feeds comprised only 9 per cent, and other mixed feeds, except distillers' grains, only 6 per cent, of the total.

Of the total concentrates used by cows, 44 per cent were by-products derived largely from corn, 21 per cent were by-products from wheat, and 26 per cent were by-products from other sources, some containing both corn and wheat by-products, making a total of 91 per cent of by-products. Of the total, 82 per cent were unmixed feeds. Altho in general the price per ton is lower, the cost of energy or nutriment in molasses feeds is higher than in such feeds as gluten, distillers' grains, and cottonseed meal. There is considerable variation in the cost of nutriment in standard feeds. This matter deserves careful consideration in planning rations. From the standpoint of the cost of energy, cornmeal, cottonseed meal, gluten, and distillers' grains, and several other high-protein feeds, are the more economical. On the basis of the energy contained, wheat feed and wheat bran are frequently expensive feeds, but from the standpoint of the physiological effect on the animal it is often advisable to purchase them even at greater cost.

It was urged as a war measure that New York farmers should raise more grain for cow feed. But cereals have a small protein content, and the dairy farmer wants a high-protein by-product feed to use with corn silage and mixed hay, rather than a low-protein home-grown grain.. It might be desirable to raise the grain; but if one raises grain fit for human food, he will often benefit not only himself but also the public by selling it and buying high-protein by-products for his dairy.

Proportion of energy of winter ration in grain.—After being grouped according to season of milk production, the records were subsorted into groups

according to the percentage of the therms in the winter ration that came from grain. As shown by the figures in table 83, the larger the proportion of energy in the winter ration from grain, the higher is the production, especially in the summer dairies. This is in spite of the fact that a large proportion of the grain in the ration was accompanied by lighter total feeding, particularly in the winter dairies. Farmers with good cows may feed more grain relatively than those with poor cows, but it is never possible to tell how much of the high yield is due to the cow and how much to the extra grain. The common practice is to allow cows as much roughage as they will eat clean, and grain according to its price and to the price of milk. When milk is relatively high, more grain is usually fed and the proportion of grain to roughage then changes. The cost of milk production is much less and the profit per cow higher when a large proportion of the energy in the winter ration comes from grain. Also, more milk is produced to each dollar of feed cost. Since, however, the nutritive ratio of grain is narrow, a relatively large proportion of grain in a ration means relatively more protein. It is possible that much of the effect of the rations with more grain may have been due to the more liberal supply of protein.

It is of importance to watch the condition of a cow as she advances in lactation, in order to tell whether or not a sufficient quantity of the right kind of grain is being given. Sometimes it happens that good producers are allowed to lose too much body weight or to shrink in milk flow, because it is not realized how much nutriment their production requires. A relatively heavy allowance of grain and less roughage reduces the bulk of the ration. Inasmuch as a cow's capacity for handling feed is limited among other things by the bulk of the ration, it becomes necessary to furnish large quantities of concentrates to increase the proportion of energy to bulk, the amount depending on the character of the roughage. The more grain used, the more essential it is that it should include a variety of feeds.

The extent to which additional amounts of grain fed in winter increase the milk flow depends much on the time of calving. A spring-fresh cow will not respond in yield to winter grain as will a fall-fresh cow, and cannot profitably use so much grain as one that is at the beginning of the lactation period during winter. Largely for this reason, less grain is used during the winter in summer dairies. When all the cows freshen in the spring very little grain is used.

Heavier grain feeding not only increases the cost of feed, but also increases the other costs. More milk means more labor, and higher interest and depreciation costs on the cow.

Selecting the lightest grain feeders tends to select the most extensive dairies. These herds produce more milk per pound of grain, because more of it is produced on cheap feed. As more winter feed is used, less milk per pound of feed or per dollar of cost is obtained.

TABLE 83. PROPORTION OF ENERGY IN THE WINTER RATION IN GRAIN RELATED TO PRODUCTION, COST OF PRODUCTION, AND PROFITS

Per cent of milk sold during May, June, and July	Per cent of therms of winter ration in grain	Number of farms	Number of cows	Pounds of milk produced per cow			Cow cost of milk sold per 100 pounds	Profit or loss per cow	Value of feed except pasture, per cow	Pounds of milk produced to each dollar's worth of feed except pasture	
				Total for year	October to April inclusive	May to September inclusive				Total for year	Winter only
Less than 33	Under 25.	13	165.5	5,543	3,414	2,129	$2.06	—$17	$67	82	51
	25–37....	27	367 5	5,850	3,503	2,347	1.78	— 3	59	99	59
	Over 37.	16	265.0	5,957	3,563	2,394	1.70	+ 1	58	103	61
From 33 to 40	Under 25.	13	217.0	5,017	2,366	2,651	$1.87	—$12	$50	100	47
	25–37 ...	28	417.5	5,568	2,664	2,904	1.60	0	49	113	54
	Over 37..	11	122.5	5,580	2,601	2,979	1.45	+ 8	45	125	58
More than 40	Under 25.	18	214.0	5,124	1,922	3,202	$1.67	—$ 6	$43	120	45
	25–33....	14	171.5	5,093	1,959	3,134	1 50	+ 2	38	134	52
	Over 33 .	9	117.5	5,730	2,239	3,491	1.45	+ 4	45	128	50

Proportion of energy of grain in winter ration from feeds containing more than 25 per cent of protein.— The principal forage crops grown on these farms are low in protein. This tends to make a wide ration. To supply this deficiency of protein in the roughage it is very important that the concentrates used should be high-protein feeds. This fact is not yet fully appreciated by all dairymen. If corn silage with well-matured ears is used, the proportion of high-protein grains may be increased with good results. High-protein feeds make better manure. It is an unusual practice to feed nothing but concentrates containing more than 25 per cent of protein, but when the silage contains plenty of grain this is sometimes found desirable. Production is better, cost of production is less, and the profit per cow is higher, the larger the proportion of the therms of the winter grain carried in feeds containing more than 25 per cent of protein, regardless of the season of milk production.

With the summer dairies an increase from 5 to 86 per cent of the energy in the winter grain coming from high-protein feeds was accompanied by a decrease in the cost of milk from $1.75 to $1.35 a hundred pounds, and a change in profit from a loss of $11 a cow to a gain of $10 a cow. With winter dairies an increase from 32 to 82 per cent of the energy coming from high-protein feeds was accompanied by a decrease in the cost of milk from $1.96 to $1.58 a hundred pounds, and a change in profit from a loss of $14 a cow to a gain of $10 a cow. It is likely that the farms using the high-protein concentrates also had roughage containing more protein, and perhaps better cows. Possibly these results cannot be attributed altogether to the difference in protein content of the grain part of the ration, altho it is safe to believe that most of the difference is due to a liberal supply of protein.

More than one-fourth of the solids of milk are protein. Protein furnishes much of the energy of the animal's needs, and also factors largely in the growth of the fetus. Therefore it is important to furnish sufficient protein. In some herds not enough protein is supplied for the most economical production. The cost per unit of energy or nutriment should be the guide in making the choice of feeds, not the cost per ton. In some instances low-protein feeds are chosen because they are erroneously supposed to be cheaper. Another factor that discourages the use of high-protein by-products is the fear of udder trouble or other injury to the cow. Some farmers will use no gluten, and others will use no cottonseed meal, because they fear the use of these feeds will cause garget or other udder troubles or will wear the cow out too quickly. As a matter of fact, more care must be exercised in the use of these two feeds than with any others commonly fed to dairy cows. Especially is this true if there is little or no succulent feed used. The supply of distillers' and brewers' grains is being cut off. But there is some cottonseed meal now being used for fertilizer that might be fed to cattle. Quantities of linseed cake, which was formerly exported,

may be used for stock feeding. Coconut meal, peanut meal, and other high-protein feeds are coming on the market in small amounts. But the chief sources of protein which at present are not most fully used are cottonseed meal and oilmeal. Many dairymen might find it profitable to use a larger proportion of these feeds, especially oilmeal.

A better way of studying the effect of protein supply would have been to sort the records by the percentage of protein in the grain. This would have involved many more calculations, but it would have given a more specific idea of how much protein the grain should contain.

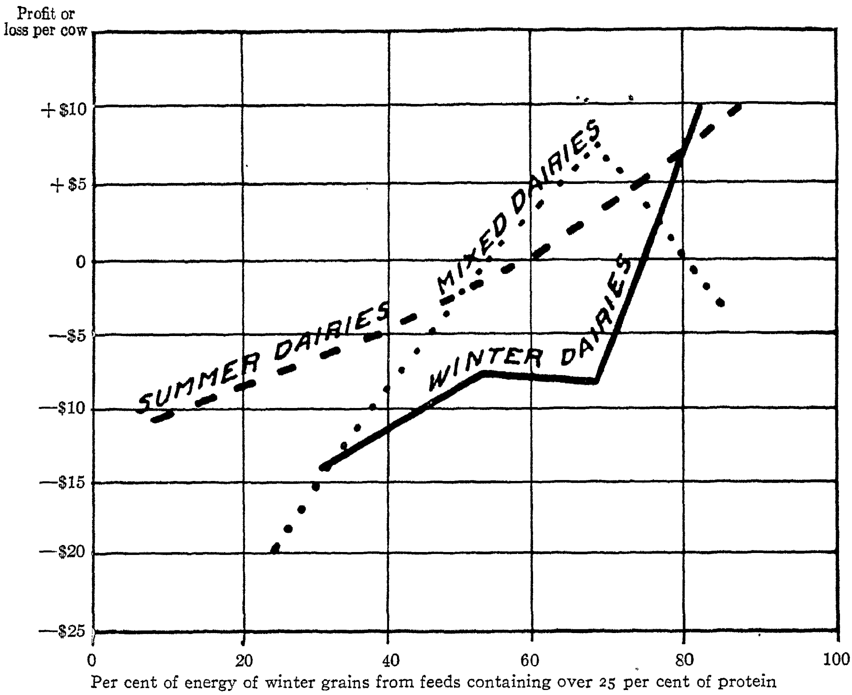


FIG. 61. INCREASED PROFIT RESULTING FROM LIBERAL USE OF HIGH-PROTEIN CONCENTRATES

The high prices of concentrates have led to recommendations that dairy farmers grow more grain for cows on their own farms, and depend less than in the past on purchased by-products. On most dairy farms this would mean keeping less cows, or replacing some cash crops — often a crop that could be used directly for human food — with corn for grain, oats, barley, or buckwheat, to be used as cattle feed, and thus decreasing the size of the business. Also, it would mean providing largely carbohydrate material rather than protein, all of which is undesirable.

Another way of getting more protein into the ration is by the use of leguminous roughages. Unfortunately, in most regions where dairying

TABLE 84. PROPORTION OF ENERGY OF GRAIN IN WINTER RATION FROM FEEDS CONTAINING MORE THAN 25 PER CENT OF PROTEIN, AS RELATED TO PRODUCTION, COST OF PRODUCTION, AND PROFITS

Per cent of milk sold during May, June, and July	Per cent of therms in grain from feeds containing more than 25 per cent of protein	Number of farms	Number of cows	Therms per cow: In grains with 25 per cent or less of protein	Therms per cow: In grains with more than 25 per cent of protein	Therms per cow: Total winter ration	Per cent of therms in grains containing more than 25 per cent of protein	Number of cows per farm	Pounds of milk produced per cow: Total for year	Pounds of milk produced per cow: October to April inclusive	Pounds of milk produced per cow: May to September inclusive	Cow cost of milk per 100 pounds	Profit or loss per cow	Value of feed except pasture, per cow	Pounds of milk produced in winter per pound of grain
Less than 33	Under 40.	7	99.5	748	345	3,882	31.6	14.2	5,932	3,480	2,452	$1.96	—$14	$71	2.3
	40–60....	15	176.5	479	555	3,430	53.7	11.8	5,558	3,303	2,255	1.84	— 7	57	2.3
	60–75....	22	339.5	365	736	3,474	66.9	15.4	5,706	3,376	2,330	1 88	— 8	61	2.1
	Over 75..	12	182.5	193	856	3,111	81.6	15.2	6,232	3,951	2,281	1.58	+ 10	57	2.6
From 33 to 40	Under 40.	9	114.5	736	254	3,226	25.7	12.7	5,281	2,600	2,681	2.00	— 20	56	1.8
	40–60....	18	272.0	419	412	2,694	49.6	15.1	5,383	2,585	2,798	1.63	— 2	47	2.1
	60–75....	13	195.5	243	520	2,719	68.2	15.0	5,523	2,521	3,002	1.46	+ 7	46	2.3
	Over 75..	12	175.0	115	642	2,751	84.8	14.6	5,419	2,518	2,901	1.67	— 3	50	2.4
More than 40	Under 25.	5	55 0	543	29	2,615	5.0	11.0	4,836	1,685	3,151	1.75	— 11	41	1.9
	25–60....	20	252.5	375	312	2,562	45.4	12 6	5,215	1,996	3,219	1.62	— 4	41	2.0
	60–75....	9	105.0	228	507	2,786	69.0	11.7	5,223	1,956	3,267	1.51	+ 2	45	1.9
	Over 75..	7	90.5	105	668	2,531	86.4	12.9	5,659	2,304	3,355	1.35	+ 10	39	2.2

TABLE 85. RELATION OF AMOUNT OF CONCENTRATES USED, TO DIMINISHING RETURNS

Per cent of milk sold during May, June, and July	Pounds of grain fed per cow	Average pounds of grain fed per cow	Pounds of milk produced per cow	Increase in pounds of grain per cow	Increase in pounds of milk per cow	Increase in value of feed except pasture, per cow	Pounds of milk sold per dollar of additional feed cost except pasture	Value of increased amount of milk sold per dollar of additional feed cost except pasture	Increase in total returns per dollar of increased cost	Pounds of milk produced	
										Per pound of grain fed	Per dollar's worth of feed except pasture
Less than 33	Under 1200.	965	5,264	......	......	......	......	......	......	5.5	117
	1200–1600..	1,375	5,387	410	123	$11	11	$0.45	$0.26	3.9	96
	Over 1600..	2,077	6,257	702	870	12	72	1.42	1.46	3.0	92
From 33 to 40	Under 1100.	912	5,024	......	......	......	......	......	......	5.5	123
	1100–1500..	1,272	5,291	360	267	9	30	0.67	0.70	4.2	106
	Over 1500..	1,741	5,895	469	604	6	101	1.50	0.89	3.4	105
More than 40	Under 1000.	830	5,042	......	......	......	......	......	......	6.1	136
	1000–1200..	1,082	5,045	252	3	2	2	0.00	0.25	4.7	129
	Over 1200..	1,598	5,747	516	702	11	64	1.00	0.65	3.6	115

is the leading enterprise, the soil, the length of the rotation, and other factors are not conducive to the profitable production of alfalfa. Very little alfalfa is grown in most dairy sections of New York, and relatively few dairy cows are kept where most of the alfalfa is grown. Clover hay must furnish the bulk of the leguminous dry roughage in most regions of the State where dairy cattle are kept, but on many of the farms in Broome County the supply of clover is limited. Until more leguminous roughage is grown, the grain mixture will need to contain a great deal of protein.

The relation of the proportion of energy of grain in winter rations containing more than 25 per cent of protein, to production, cost of production, and profits, is shown in table 84. The relation of the amount of concentrates used, to diminishing returns, is shown in table 85.

Use of succulent feed

Of the 69 herds fed silage, 46 produced less than 36 per cent of the milk sold during May, June, and July, and 23 produced 36 per cent or more of the milk sold during those months. Of the 80 herds not using silage, 35 came in the first group and 45 in the second. For convenience of discussion, the dairies whose herds produced less than 36 per cent of their product in these three months are here called *winter dairies*, and those producing 36 per cent or more of their product in those months are called *summer dairies*. This includes all dairies in two groups as to season, instead of three as before, necessitated by the small number of records. It offers a satisfactory index of the tendency toward more intensive dairy methods on the one hand, and more extensive methods on the other.

The herds in winter dairies using silage averaged four cows larger, and those in summer dairies using silage averaged about two cows larger, than in those not using silage.

Relation of the feeding of silage to other feed used.— In winter dairies the amount of grain fed per cow was approximately the same when silage was used as when none was used. The average amount of silage used was 7961 pounds per cow. The average quantity of dry forage was 2566 pounds less in herds using silage than in the others. Apparently about three pounds of silage was fed for each pound of dry forage replaced. Three pounds of silage cannot be grown in New York as cheaply as can one pound of hay, nor can it be grown for the usual price of one pound of hay. Silage is fed heavily in winter dairies because three pounds of it are worth more than one pound of hay. The cost of producing a unit of energy is probably less with silage than with most other kinds of succulent feed.

In summer dairies also, the amount of grain fed was about the same, regardless of whether or not silage was used. Farms using silage fed 5845 pounds of silage per cow. Farms not using silage fed 1620 pounds more of dry forage. In summer dairies it would appear that about three and one-half pounds of silage was substituted for each pound of dry forage.

When silage was fed, more milk was produced per cow. This averaged 661 pounds more per cow in winter dairies, but only 96 pounds more per cow in summer dairies. Feeding silage to dry cows does not materially increase production.

The figures showing these relationships are given in tables 86 to 88:

TABLE 86. RELATION OF FEEDING OF SILAGE TO FEED USED

	Less than 36 per cent of milk sold during May, June, and July		36 per cent or more of milk sold during May, June, and July		Average	
	Silage	No silage	Silage	No silage	Silage	No silage
Number of farms	46	35	23	45	69	80
Number of cows	722.5	414.5	349.0	572.0	1,071.5	986.5
Cows per farm	15.7	11.8	15.2	12.7	15.5	12.3
Pounds of milk produced per cow	5,930	5,269	5,399	5,303	5,756	5,289
Pounds of grain fed per cow	1,569	1,554	1,217	1,212	1,454	1,356
Pounds of silage per cow	7,961	....	5,845	....	7,272	....
Pounds of other succulent feed per cow	826	863	854	891	835	880
Pounds of dry forage per cow	3,350	5,916	3,005	4,625	3,237	5,167
Value of feed except pasture, per cow	$61	$51	$49	$41	$57	$45

TABLE 87. RELATION OF FEEDING OF SILAGE TO AVERAGE AMOUNTS OF FEED USED PER COW PER DAY IN THE WINTER PERIOD

(36 per cent or more of milk sold during May, June, and July)

	Pounds of feed	Pounds of digestible nutrients	Pounds of digestible crude protein	Therms	Nutritive ratio
Silage, 23 farms, 349 cows, 210 days					
Grain	4.887	3.614	0.860	3.522	1:3.2
Silage	27.622	3.674	0.276	3.301	1:12.3
Other succulent feed	1.336	0.106	0.014	0.092	1:6.6
Dry forage	14.308	6.696	0.586	5.764	1:10.4
Total	......	14.090	1.736	12.679	1:7.1
No silage, 45 farms, 572 cows, 203 days					
Grain	5.223	3.895	0.863	3.779	1:3.5
Silage	......	......	......	......	.....
Other succulent feed	0.877	0.155	0.015	0.155	1:9.3
Dry forage	22.729	10.620	0.831	8.880	1:11.8
Total	......	14.670	1.709	12.814	1:7.6

TABLE 88. RELATION OF FEEDING OF SILAGE TO AVERAGE AMOUNTS OF FEED USED PER COW PER DAY IN THE WINTER PERIOD

(Less than 36 per cent of milk sold during May, June, and July)

	Pounds of feed	Pounds of digestible nutrients	Pounds of digestible crude protein	Therms	Nutritive ratio
Silage, 46 farms, 722.5 cows, 206 days					
Grain	6.736	4.976	1.217	4.828	1:3.1
Silage	37.984	5.066	0.381	4.539	1:12.3
Other succulent feed	1.967	0.197	0.023	0.179	1:7.6
Dry forage	16.143	7.617	0.686	6.415	1:10.1
Total	......	17.856	2.307	15.961	1:6.7
No silage, 35 farms, 414.5 cows, 205 days					
Grain	6.813	5.035	1.187	4.888	1:3.2
Silage	......	....	....	......	......
Other succulent feed	1.545	0.120	0.017	0.125	1:6.1
Dry forage	28.810	13.422	1.070	11.184	1:11.5
Total	......	18.577	2.274	16.197	1:7.2

The quantities of feed used per hundred pounds of milk produced with and without silage are given in table 89:

TABLE 89. RELATION OF FEEDING OF SILAGE TO AMOUNTS OF FEED USED PER HUNDRED POUNDS OF MILK

	Less than 36 per cent of milk sold during May, June, and July		36 per cent or more of milk sold during May, June, and July		Average	
	Silage	No silage	Silage	No silage	Silage	No silage
Grain	26.5	29.5	22.5	22.9	25.3	25.6
Silage	134.2	....	108.3	....	126.3	....
Other succulent feed	13.9	16.4	15.8	16.8	14.5	16.6
Dry forage	56 5	112.3	55.7	87.2	56.2	97.7

Relation of the feeding of silage to cost and returns.— In winter dairies the herd cost of milk was 13 cents a hundred pounds, and the cow cost was 15 cents a hundred pounds, higher for herds not using silage. This difference is not entirely due to the lack of silage. The herds were smaller. On the other hand, when no silage was used, a larger proportion of the milk was produced in summer, which tends to lower the cost. Had silage been charged at $7.26 a ton instead of at $5 a ton in winter dairies using silage, they would still have paid as well as winter dairies not using silage.

For the summer dairies, however, both the herd cost and the cow cost of milk production in herds not using silage was 23 cents a hundred pounds less than in herds using silage. This is in spite of the fact that the no-silage herds were smaller. It would have been necessary to charge silage at $1.92 a ton instead of at $5 in summer dairies using silage, to have had them pay as well as summer dairies not using silage.

With the more intensive systems of dairying, silage seems to be essential for the most economical production. On the other hand, with cows that freshen in the spring good results may be obtained without its use. The economic advantages of the silo are in proportion to the size of the herd as well as to the intensity of the system. That farmers appreciate this is shown by the fact that the large herds and winter dairies more frequently have silos. Figures bearing on this relation are given in tables 90 to 93.

TABLE 90. RELATION OF FEEDING OF SILAGE TO PRODUCTION, SEASON OF PRODUCTION, COST OF PRODUCTION, AND PROFITS

	Less than 36 per cent of milk sold during May, June, and July		36 per cent or more of milk sold during May, June, and July		Average	
	Silage	No silage	Silage	No silage	Silage	No silage
Average per cent produced in May, June, and July	28	31	39	41	32	30
Average per cent produced in November, December, January, and February	33	31	22	18	37	23
Herd cost of milk per hundred pounds	$1.78	$1.91	$1.69	$1.46	$1.75	$1.65
Cow cost of milk per hundred pounds	$1.75	$1.90	$1.69	$1.46	$1.73	$1.64
Amount received per hundred pounds of milk sold	$1.71	$1.68	$1.58	$1.55	$1.67	$1.60
Total costs per cow	$116.00	$111.00	$102.00	$90.00	$111.00	$99.00
Total returns per cow	$114.00	$100.00	$97.00	$94.00	$108.00	$97.00
Profit or loss per cow	—$2.00	—$11.00	—$5.00	+$4.00	—$3.00	—$2.00
Receipts per cow from milk sold	$94.00	$81.00	$77.00	$75.00	$89.00	$78.00

With winter dairies, when more than 30 per cent of the energy came from succulent feed, production per cow in winter was 821 pounds more than when less than 10 per cent of the energy came from succulent feed. With summer dairies the influence of succulent feeds on production was not so marked. This again is due to the fact that with the summer system more of the cows are dry or nearly dry in winter, and hence do not respond in yield to the use of silage. When silage is not fed, turnips, mangels, cabbages, or other root crops, or laxative feed such as oilmeal and wheat bran, may be depended on to keep the cows in good condition before calv-

TABLE 91. RELATION OF SEASON OF MILK PRODUCTION AND PROPORTION OF ENERGY OF THE WINTER RATION IN SUCCULENT FEED, TO PRODUCTION, COST OF PRODUCTION, AND PROFITS

Per cent of milk sold during May, June, and July	Per cent of therms of winter ration in succulent feed	Number of farms	Number of cows	Pounds of milk produced per cow			Cow cost of milk per 100 pounds	Profit or loss per cow	Value of feed except pasture, per cow	Pounds of milk produced to each dollar's worth of feed except pasture	
				Total for year	October to April inclusive	May to September inclusive				Total for year	Winter only
Less than 33	Under 10	24	298.5	5,313	3,067	2,246	$1.94	—$11	$56	95	55
	10–30	17	213.0	5,950	3,598	2,352	1.83	— 7	62	97	58
	Over 30	15	286.5	6,222	3,888	2,334	1.68	+ 4	64	97	60
From 33 to 40	Under 10	27	348.5	5,326	2,471	2,855	1.62	— 2	44	121	56
	10–30	14	225.0	5,519	2,699	2,820	1.69	— 4	55	100	49
	Over 30	11	183.5	5,444	2,592	2,852	1.64	— 1	51	106	51
More than 40	None	17	201.0	5,147	1,929	3,218	1 46	+ 3	39	131	49
	Under 15	17	211.0	5,400	2,082	3,318	1.46	+ 5	41	130	50
	15 or over	7	91.0	5,158	2,014	3,144	2.01	— 23	47	111	43

ing. With the summer system, which usually depends for its success on cheap winter feeding, some such means of furnishing a little succulence generally proves more economical than does costly silage fed regularly. Probably most cows do not get sufficient water, either because of infrequent waterings or because the water is very cold and they refuse to drink. Altho plenty of water is at all times desirable, it does not eliminate the advantages of succulent feed in the ration.

TABLE 92. RELATION OF SEASON OF MILK PRODUCTION AND FEEDING OF SILAGE TO NUTRIMENT USED PER UNIT OF PRODUCT IN WINTER

(Per 100 pounds of milk produced)

	Silage		No silage	
	Less than 36 per cent of milk sold during May, June, and July	36 per cent or more of milk sold during May, June, and July	Less than 36 per cent of milk sold during May, June, and July	36 per cent or more of milk sold during May, June, and July
Digestible nutrients (pounds)	103.86	118.68	128.70	131.53
Digestible crude protein (pounds)	13.42	14.62	15.75	15.32
Therms	92.83	106.79	112.20	114.88
Average butterfat test	4.0	4.1	4.0	4.1
Per cent of milk produced in stabling period	59.7	46.2	56.2	42.7

TABLE 93. RELATION OF FEEDING OF SILAGE TO PERCENTAGE OF NUTRIMENT USED IN WINTER RATION RETURNED IN MILK PRODUCED IN WINTER

	Silage		No silage	
	Less than 36 per cent of milk sold during May, June, and July	36 per cent or more of milk sold during May, June, and July	Less than 36 per cent of milk sold during May, June, and July	36 per cent or more of milk sold during May, June, and July
Digestible nutrients*	17.2	15.1	13.9	13.6
Digestible crude protein†	24.6	22.6	21.0	21.5
Therms‡	31.3	27.2	25.9	25.3

*17.9 pounds digestible nutrients to 100 pounds of milk. (*Feeds and Feeding*, by Henry and Morrison, page 657.)
†3.3 pounds digestible protein to 100 pounds of milk. (*Feeds and Feeding*, by Henry and Morrison, page 657.)
‡29.01 therms to 100 pounds of milk. (Pennsylvania State College, Bulletin 143, page 23.)

With the silage rations, less nutriment was required for a hundred pounds of milk produced than with no-silage rations. The difference was greatest in the winter dairies. Perhaps a larger part of the no-silage ration was wasted or was used for bedding than of the silage ration. Also, the silage-

fed herds produced a larger proportion of milk in winter, and this tended to lower the nutriment used per unit of winter product.

A larger proportion of the nutriment fed in winter is returned with the silage rations than with no-silage rations and when more of the milk is produced in winter than when a relatively large proportion is produced in summer.

Relation of the feeding of silage and costs other than barn feed, to costs and returns.— Since the cost of barn feed is usually greater than all other costs of production combined, the question of feeding deserves the attention usually given it. But often the other costs are so high that even with economical feeding a large loss results. This may be due to extra time required in taking care of cows or in hauling milk, to expensive shelter, or to other excessive costs. It is therefore important also that the costs other than feed be studied on each farm. These costs depend much on the size of herd. But frequently they are low in small herds and high in large herds. Consequently, the number of cows is not always an indication of what are the costs other than feed.

In tables 94 and 95 there are considered four large groups of farms: winter dairies feeding silage and those not feeding silage, and summer

TABLE 94. RELATION OF COSTS PER COW, EXCEPT FOR BARN FEED, TO SIZE OF HERD, COST OF PRODUCTION, AND PROFITS, IN WINTER DAIRIES

(Less than 36 per cent of milk sold during May, June, and July)

Costs per cow except for barn feed	Number of farms	Number of cows per farm	Total costs per cow	Total returns per cow	Profit or loss per cow	Herd cost of milk per 100 pounds	Cow cost of milk per 100 pounds	Average cost except for barn feed	Value of barn feed
Herds fed silage:									
Under $50	10	18.7	$ 95	$104	+$ 9	$1.49	$1.48	$41	$54
$50-$65	27	16.6	120	118	— 2	1.80	1.77	56	64
Over $65	9	9.8	138	111	— 27	2.27	2.22	75	.63
Herds not fed silage:									
Under $50	9	9 6	91	96	+ 5	1.53	1.56	45	46
$50-$65	16	13.8	110	100	— 10	1 93	1.88	56	54
Over $65	10	10.8	128	103	— 25	2.14	2.15	78	50

TABLE 95. RELATION OF COSTS PER COW, EXCEPT FOR BARN FEED, TO SIZE OF HERD, COST OF PRODUCTION, AND PROFITS, IN SUMMER DAIRIES

(36 per cent or more of milk sold during May, June, and July)

Costs per cow except for barn feed	Number of farms	Number of cows per farm	Total costs per cow	Total returns per cow	Profit or loss per cow	Herd cost of milk per 100 pounds	Cow cost of milk per 100 pounds	Average cost except for barn feed	Value of barn feed
Herds fed silage:									
Under $50	11	16.6	$ 87	$ 94	+$ 7	$1.46	$1.46	$43	$44
$50-$65	7	15.6	116	103	— 13	1.79	1.81	60	56
Over $65	5	11.5	126	93	— 33	2.23	2.21	75	51
Herds not fed silage:									
Under $50	23	14.4	80	92	+ 12	1.26	1.30	41	39
$50-$65	17	11.4	102	97	— 5	1.69	1.67	57	45
Over $65	5	9.4	110	100	— 10	1.77	1.73	69	41

dairies feeding silage and those not feeding silage. The intensity of the system lessens in the order given. The cost of production also decreases and profits increase as less intensive methods are used. That is, the cost of producing milk is least, and the profit per cow is greatest, in summer dairies not feeding silage which also keep the costs other than barn feed below $50 a cow.

Combined effect of large proportion of energy in both grains and succulent feed

Of the 56 dairies producing less than 33 per cent of the milk in May, June, and July, with an average of 51.9 per cent in the six months beginning October 1, there were 13 that used rations in which more than 25 per cent (average 32.4 per cent) of the energy was furnished by the grain and more than 30 per cent (average 39.5 per cent) was furnished by the succulent feed. There were 236.5 cows in these 13 herds, an average of 18.2 to a herd. The average production was 6253 pounds, the cost of milk $1.57 a hundred pounds, and the profit $10.93 a cow. These 13 herds each had only four more cows on the average than had the entire 56 herds, but the production averaged 431 pounds more, the profit was $18 a cow higher, and the cost of production was 24 cents less per hundred pounds, than for the 56 herds.

The 13 herds used 78.6 therms per hundred pounds of milk produced in winter, as against an average of 95.75 therms for the 56 herds. Thus

TABLE 96. PRODUCTION, COST OF FRODUCTION PROFITS, AND ENERGY USED, WHEN MORE THAN 25 PER CENT OF THE THERMS IN THE WINTER RATION WERE IN GRAIN AND MORE THAN 30 PER CENT WERE IN SUCCULENT FEED

(Less than 33 per cent of milk sold during May, June, and July)

Number of farms	13
Number of cows	236.5
Cows per farm	18.2
Pounds of milk produced per cow	6,253
Cow cost of milk per hundredweight	$1.57
Profit on each cow	$10.93

	Therms per 100 pounds of milk produced			
	Pasture period (therms)	Winter period		Entire year (therms)
		Therms	Per cent	
Grain	4.0	25.5	32.4	17.3
Succulent feed	2.1	31.0	39.5	19.9
Dry forage	0.5	22.1	28.1	13.8
Total	6.6	78.6	100.0	51.0
Value of feed, except pasture, per hundredweight of milk produced	$0.94			
Value of feed, except pasture, per 100 therms	$1.94			

it may be seen that feed was much more efficiently used when the ration carried a large proportion of the energy in grain and also a large proportion in succulent feed. The data are given in table 96.

Ration of the highest-producing and most profitable herd

The feed used by the highest-producing herd, which was also the herd showing the highest profit on cows, is shown in table 97:

TABLE 97. RATION OF THE HIGHEST-PRODUCING AND MOST PROFITABLE HERD

Number of cows	29
Pounds of milk produced per cow	8,392
Per cent of milk produced in seven months, October to April, inclusive	71.8
Cost of milk per hundredweight	$1.44
Profit per cow	$42

Kind of feed	Pounds per cow per day in winter	Therms per pound	Therms per cow per day in winter	Per cent
Grain:				
High-protein:				
Brewers' dried grains	3.64	0.534	....	....
Dry equivalent of brewers' grains, wet	3.03	0.534	....	....
Cottonseed meal	0.49	0.900	....	....
Malt sprouts	0.65	0.727	....	....
Low-protein:				
Cornmeal	0.38	0.888	....	....
Wheat bran	0.73	0.530	....	....
Salt	0.26	....	....	....
Total	9.18	....	5.20	27.3
Succulent feed:				
Corn silage	66.66	0.120	8.00	....
Mangels	11.39	0.057	0.65	....
Total	78.05	....	8.65	45.3
Dry forage:				
Clover hay (excellent quality)	11.87	0.387	4.59	....
Oat hay	1.95	0.322	0.63	....
Total	13.82	....	5.22	27.4
Total	....	....	19.07	....

The farmer owning this herd fed one pound of grain for three pounds of milk in winter. His silage was good and he had excellent river-bottom clover hay for dry roughage. But 72.6 per cent of the energy of the winter ration came from grain and succulent feed, and 86 per cent of the energy of the grain was in high-protein feeds.

Practical feeders who make winter milk, know that there is more to skillful feeding than simply furnishing enough nutriment, enough protein, or enough energy. Altho this is essential, a proper share must come from grain, a proper share from succulent feed, and not too large a proportion from dry roughage, if the most economical production is to be

expected. A common recommendation has been that about one-third of the nutriment of the ration should be furnished by each of the three classes mentioned.

The findings of this investigation check closely with this recommendation. On the average, 40 per cent of the energy from grain, and from 35 to 40 per cent from succulent feed, gave the best results when the production was about equal in the pasture and winter periods. This allows for about 20 to 25 per cent from dry forage. It remains to be seen whether or not differences in the relative prices of grain, succulent feed, and dry forage, and in the quality of the hay, would affect these conclusions.

As showing the practical application of these findings in compounding rations, the following theoretical example may be applied: Let it be supposed that a cow produces in winter 30 pounds of 4-per-cent milk daily, and that one pound of grain is to be fed for each three pounds of milk. Then 10 pounds of grain (30 ÷ 3) would be fed daily. Assuming that 75 per cent, or thereabout, of the energy should come from high-protein feed, the daily grain ration might be as follows:

Kind of feed	Number of pounds	Number of therms per pound	Number of therms	Per cent of therms	
High-protein:					
Gluten feed	4	0.807	3.228	42.1	77.2
Cottonseed meal	2	0.900	1.800	23.5	
Oilmeal	1	0.889	0.889	11.6	
Low-protein:					
Wheat bran	2	0.530	1.060	13.8	22.8
Ground oats	1	0.686	0.686	9.0	
Total	10	....	7.663		100.0

Assuming further that well-eared and well-matured corn silage and mixed hay will be fed, and that the following proportions are desired, then the requirements would be as follows:

	Per cent of energy of ration	Number of therms	Number of pounds required daily to furnish these therms
Grain	40	7.663	10.0
Succulent feed	35	6.705	42.2
Dry forage	25	4.790	11.7
Total	100	19.158	....

Putney and Armsby standard for a 1000-pound cow, 14.1 therms

Production per cow

The production of milk per cow averaged less than 4500 pounds in 12 per cent of the herds studied, more than 4500 but not more than 5500 pounds in 39 per cent of the herds, more than 5500 but not more than 6500 pounds in 36 per cent of the herds, and more than 6500 pounds in 13 per cent of the herds. The lowest average herd production was 3258 pounds per cow and the highest was 8392 pounds. Records of individual cows were not obtained, but some were above and some were below these limits.

The herds with low average production had less cows than had those with higher production. The value of feed except pasture used by them was also less per cow for the former. In general, they are the herds following a less intensive system. Sorting by size of herd, season of production, and production per cow, tends to select the same herds in the extreme groups.

The figures showing the various production relationships are given in tables 98 to 100.

TABLE 98. RELATION OF PRODUCTION TO VARIOUS FACTORS

Pounds of milk produced per cow	Average pounds produced	Number of farms	Number of cows	Cows per farm	Value of feed except pasture per cow	Hundredweight of milk sold	Per cent of farms on hills	Per cent of number of farms in group	Per cent of number of cows in group	Per cent of total milk sold by group
Under 4,500.....	4,063	18	235	13.1	$41	8,598	78	12	11	8
4,500–5,500.....	4,961	58	746	12.9	47	33,592	67	39	36	32
5,501–6,500.....	5,916	54	783	14.5	53	42,767	63	36	38	41
Over 6,500.....	7,136	19	294	15.5	68	19,775	62	13	15	19

TABLE 99. RELATION OF PRODUCTION TO COSTS, RETURNS, AND PROFITS PER COW

Pounds of milk produced per cow	Average pounds produced	Pounds of milk sold per cow	Cost other than feed except pasture	Total cost per cow	Receipts per cow from milk sold	Total returns per cow	Profit or loss per cow	Per cent of farms showing a profit on cows
Under 4,500........	4,063	3,659	$50	$ 91	$ 58	$ 75	—$16	28
4,500–5,500........	4,961	4,503	52	99	73	93	— 6	34
5,501–6,500........	5,916	5,462	55	108	88	108	0	46
Over 6,500........	7,136	6,727	58	126	115	134	+ 8	58

The average cost of keeping cows producing 4063 pounds of milk was $91, of cows producing 4961 pounds $99, of cows producing 5916 pounds $108, and of cows producing 7136 pounds $126, per cow. The returns for the respective groups were $75, $93, $108, and $134 per cow. There was a loss of $16 per cow in the group of lowest production, but a gain of $8 per cow in the group of highest production. Feed costs, and the other costs as well, increased as better yields were obtained.

TABLE 100. RELATION OF PRODUCTION TO COST OF PRODUCTION AND AVERAGE PRICE FOR PRODUCT

Pounds of milk produced per cow	Average pounds produced	Cost of milk per 100 pounds		Cow cost compared with average	Relative cow cost taking first group as 100	Decrease in cow cost below preceding group	Price received per 100 pounds of milk sold
		Herd cost	Cow cost				
Under 4,500	4,063	$1.98	$2.00	+$0 31	100	.....	$1.59
4,500–5,500	4,961	1.76	1.75	+ 0.06	88	$0.25	1.62
5,501–6,500	5,916	1.63	1.63	— 0.06	82	0.12	1.61
Over 6,500	7,136	1.65	1.61	— 0.08	80	0.02	1.71

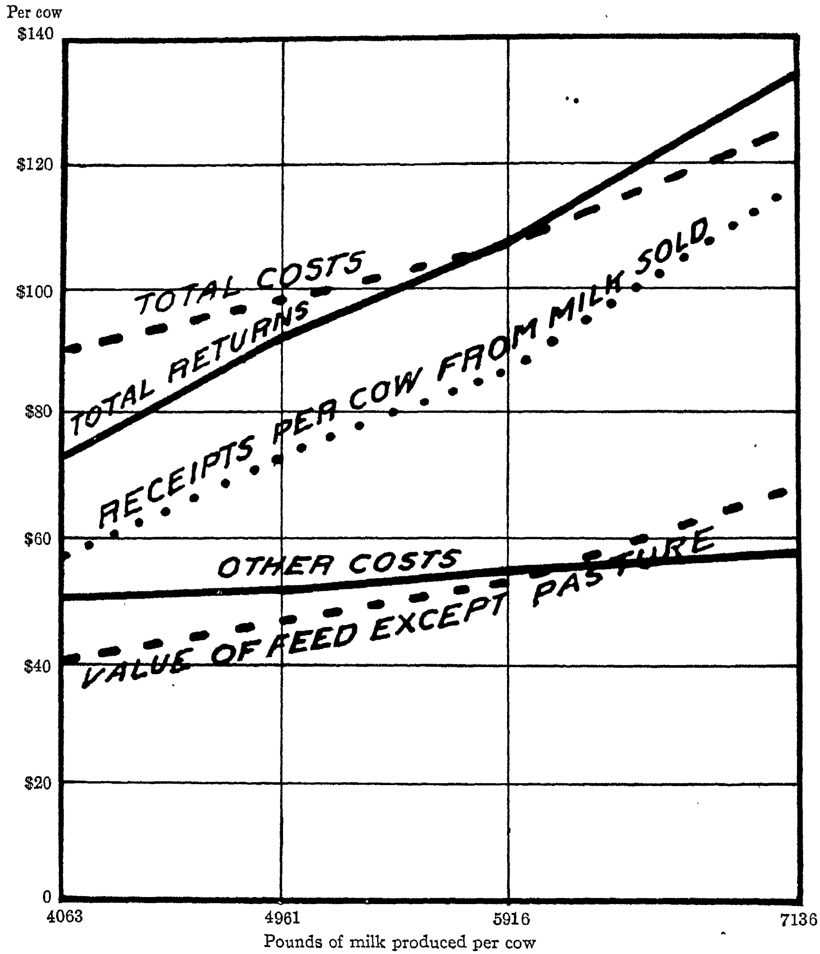


FIG. 62. RELATION OF PRODUCTION PER COW TO COSTS AND RETURNS

In the herds of low average yields the costs were less per cow, but much higher per hundred pounds of milk, than in herds with high average production. For cows producing less than 4500 pounds of milk, with an average

of 4063 pounds, the cow cost of milk was $2 per hundred pounds; with an average production of 4961 pounds, the cost was $1.75 per hundred pounds; with an average production of 5916 pounds, the cost was $1.63 per hundred pounds; and in the group containing the highest-producing herds, with an average of 7136 pounds, the cost was $1.61 per hundred pounds.

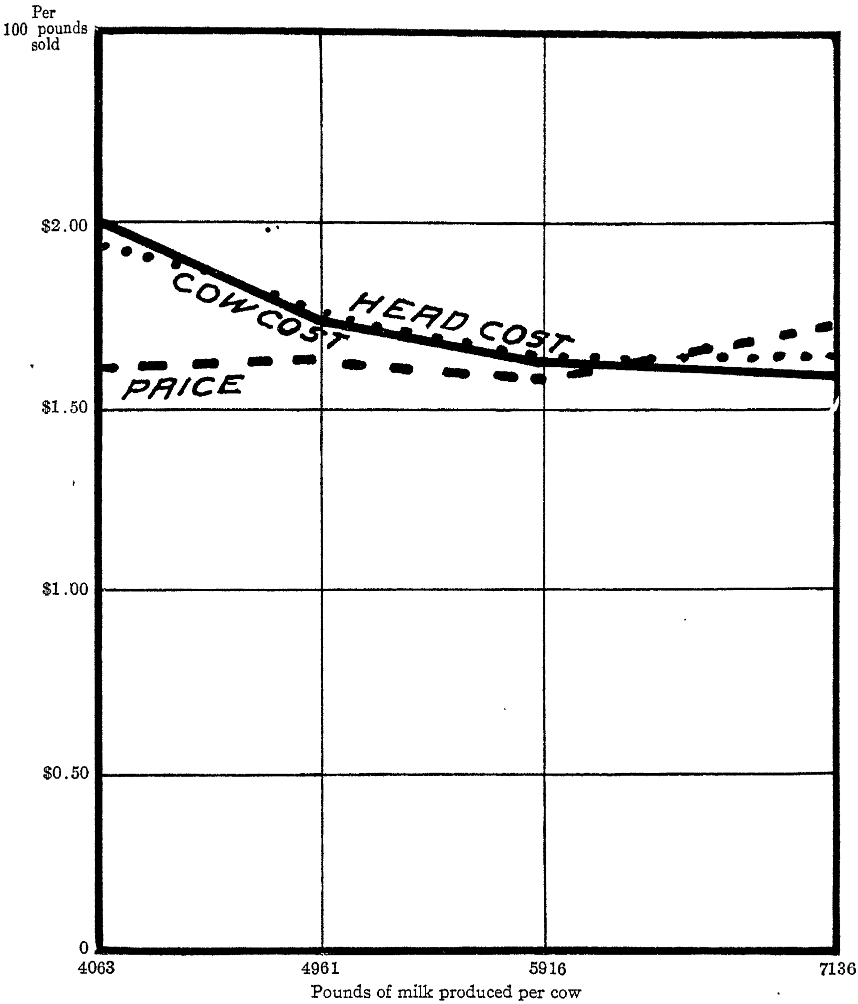
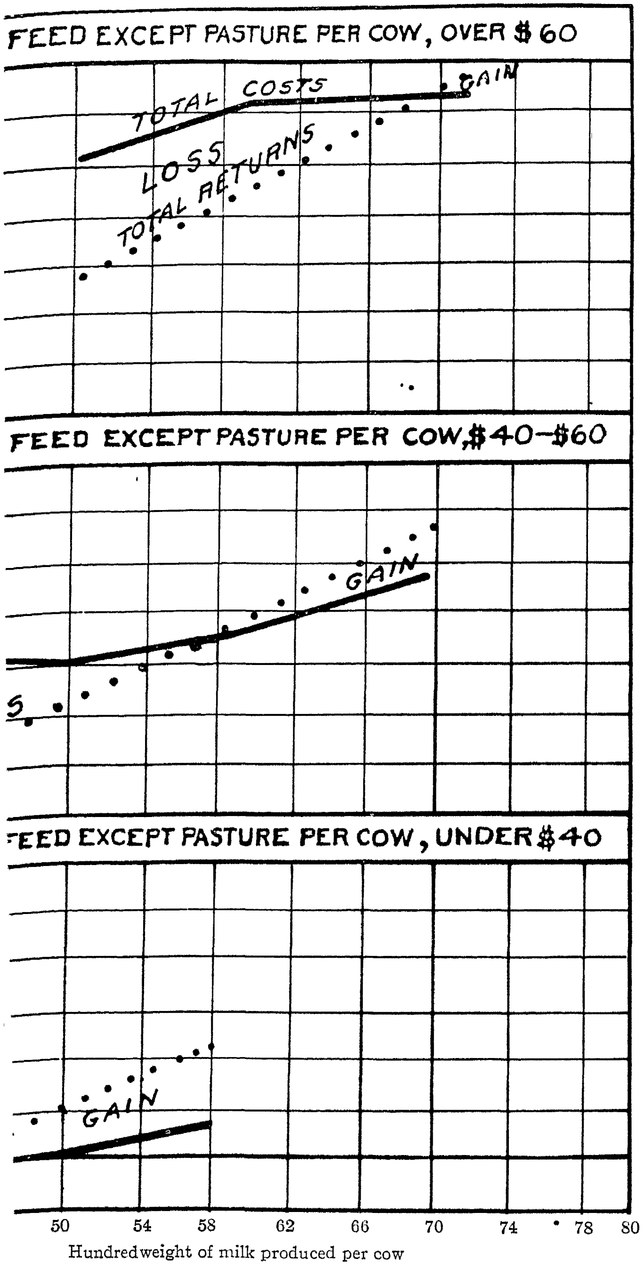


FIG. 63. RELATION OF PRODUCTION PER COW TO COST OF MILK

The herd cost of milk was not so closely correlated with production as was the cow cost. In low-producing herds the herd cost was less than the cow cost. This indicates that in these herds there was a gain on heifers. On the other hand, in high-producing herds the herd cost was greater than the cow cost. In other words, a loss on heifers in these herds increased the cost of milk.



F PRODUCTION AND INTENSITY OF FEEDING TO COSTS AND RETURNS
o show a profit with intensive feeding, than with light barn feeding and the summer system

Intensity of feeding

Herds that averaged the highest in production at the least expenditure for barn feed showed the greatest margin of profit. The greatest loss occurred when low production resulted with an expensive winter ration. The statement is often made that it costs no more to keep a high-yielding cow than a poor one, except for feed, but when more feed is given the other costs are increased also. More time is required in the feeding, in milking, and in the care of the higher-yielding cow, and many of the other costs are higher. Hence this statement is rarely true.

Of the 149 dairymen included in this study, only 11 made a systematic practice of weighing the milk from each cow, 22 kept the statements of the amount of milk sold, and 20 were in cow-testing associations. Other than this there were practically no records of production kept. Cows should be culled closer than ever before, and to do this most intelligently records of production are essential. In many cases these should be supplemented by records of feed used. Both are necessary for the most careful dairying.

The question of how much milk it is necessary for a cow to give in order to show profit is often discussed. This question can never be definitely answered. Much depends on the intensity of the system. When cows are carried thru the winter largely on roughage with little grain, a profit may result with lower production than when heavy winter feeding is the practice.

The relation of production and intensity of feeding to costs and returns is shown in figure 64 and table 101:

TABLE 101. RELATION OF PRODUCTION AND INTENSITY OF FEEDING TO COSTS AND RETURNS

Value of feed except pasture per cow	Pounds of milk produced per cow			
	Under 4500	4500–5500	5501–6500	Over 6500
Less than $40:				
Number of farms	10	19	9	Only one herd in this group
Cows per farm	12.6	11.4	13.9	
Value of feed except pasture per cow	$34	$35	$35	
Total costs per cow	$79	$80	$87	
Pounds of milk produced per cow	3,997	4,909	5,759	
Receipts per cow from milk sold	$55	$69	$85	
Total returns per cow	$73	$90	$102	
Profit or loss per cow	—$6	+$10	+$15	
Herd cost of milk per hundred pounds	$1.65	$1.31	$1.32	
Cow cost of milk per hundred pounds	$1.70	$1.34	$1.31	
Amount received for milk sold per hundred pounds	$1.55	$1.56	$1.59	
Per cent of herds showing a profit on cows	40	63	78	

TABLE 101 (*concluded*)

Value of feed except pasture per cow	Pounds of milk produced per cow			
	Under 4,500	4,500–5,500	5,501–6,500	Over 6,500
From $40 to $60:				
Number of farms	8	28	34	7
Cows per farm	13.7	14.0	14.1	11.0
Value of feed except pasture per cow	$48	$48	$51	$50
Total costs per cow	$104	$100	$106	$117
Pounds of milk produced per cow	4,138	4,955	5,910	7,009
Receipts per cow from milk sold	$61	$74	$88	$110
Total returns per cow	$77	$93	$107	$126
Profit or loss per cow	—$27	—$7	+$1	+$9
Herd cost of milk per hundred pounds	$2.34	$1.82	$1.59	$1.51
Cow cost of milk per hundred pounds	$2.33	$1.80	$1.58	$1.51
Amount received for milk sold per hundred pounds	$1.62	$1.65	$1.61	$1.65
Per cent of herds showing a profit on cows	12	25	50	71
More than $60:				
Number of farms	No herds in this group	11	11	11
Cows per farm		12.6	16.4	18.0
Value of feed except pasture per cow		$65	$71	$77
Total costs per cow		$122	$131	$134
Pounds of milk produced per cow		5,058	6,039	7,184
Receipts per cow from milk sold		$79	$92	$119
Total returns per cow		$98	$115	$137
Profit or loss per cow		—$24	—$16	+$3
Herd cost of milk per hundred pounds		$2.19	$1.94	$1.77
Cow cost of milk per hundred pounds		$2.19	$1.96	$1.71
Amount received for milk sold per hundred pounds		$1.68	$1.66	$1.76
Per cent of herds showing a profit on cows		9	9	45

Relation of production to diminishing returns

Low production, either because of poor cows or of scant feeding, usually requires more feed per unit of product than does higher production. Beyond a certain point, however, each additional pound of product requires more and more feed until the limit of the capacity of a cow to take feed is reached. Hence, highest yields require more feed per unit of product than do medium good yields. Except in the making of advanced registry records, rarely does it pay to force cows to the limit of their capacity.

In the group of herds with cows that produced less than 4500 pounds of milk, with an average production of 4063 pounds, 100 pounds of milk were produced for each dollar's worth of feed except pasture; in the next group, with an average production of 4961 pounds, this figure was 106 pounds; with an average production of 5916 pounds, for cows in the next

group, it was 111 pounds; and in the group including cows with the highest production, averaging 7136 pounds, only 105 pounds of milk were produced for each dollar's worth of barn feed (fig. 65 and table 102.)

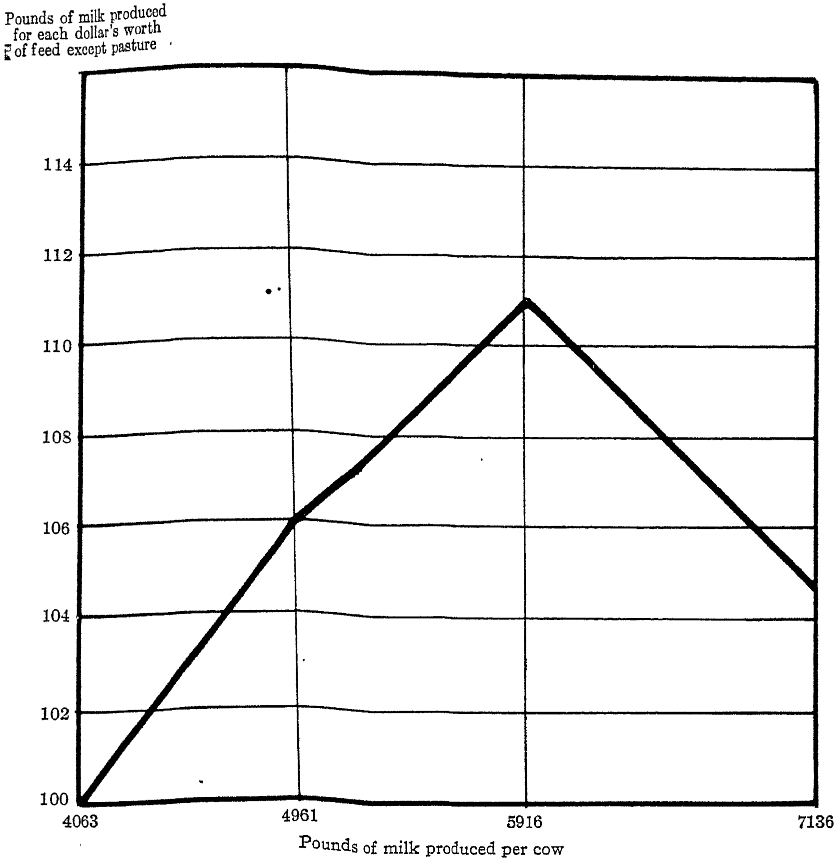


FIG. 65. RELATION OF PRODUCTION PER COW TO DIMINISHING RETURNS

It may so happen, however, that by obtaining high production at the time of year when milk sells for the highest price, altho more feed is required the increased value of the product is more than enough to pay the extra cost of feed and all the other costs. Therefore the point of greatest profit on a cow, or on a herd, does not necessarily accompany that production at which the greatest quantity of milk is obtained per unit of feed. Usually it is beyond that point.

Cows averaging 4961 pounds of milk produced 898 pounds more than the first group, at an additional cost of $8; cows averaging 5916 pounds produced 955 pounds more than the second group, at an additional cost of $9; and cows averaging 7136 pounds produced 1220 pounds more than the third group, at an additional cost of $18. As production increased, less

and less milk was produced per dollar of additional expense. When the increased production was 898 pounds, 112 pounds additional were obtained for each dollar of increased cost; when the increased production was 955 pounds, 106 pounds additional were obtained for each increase of one dollar in cost; but when the increased production was 1220 pounds, only 68 pounds additional were obtained for each dollar of increased cost.

TABLE 102. RELATION OF PRODUCTION PER COW TO DIMINISHING RETURNS

	Pounds of milk produced per cow			
	Under 4500	4500-5500	5501-6500	Over 6500
Average pounds of milk produced	4,063	4,961	5,916	7,136
Increase in pounds of milk per cow over preceding group	....	898	955	1,220
Increase in total cost per cow over preceding group	....	$8	$9	$18
Increase in pounds of milk produced per dollar of increased cost	....	112	106	68
Increase in receipts per cow from milk sold over preceding group	....	$15	$15	$27
Increase in receipts per cow from milk sold per dollar of increased cost	....	$1.88	$1.67	$1.50
Increase in returns per cow over preceding group	....	$18	$15	$26
Increase in returns per dollar of increased cost	....	$2.25	$1.67	$1.44
Increase in receipts from milk sold per dollar of increase in feed except pasture	....	$2.50	$2.50	$1.80
Pounds of milk produced per dollar's worth of feed except pasture	100	106	111	105

An increase in production of 898 pounds per cow resulted in increased returns to the amount of $2.25 for each dollar of increased cost; a further increase of 955 pounds per cow resulted in increased returns of $1.67 per dollar of increased cost; but a still further increase of 1220 pounds per cow brought increased returns of only $1.44 per dollar of increased cost.

From these results it appears that, even in the highest-producing group, the point beyond which it would no longer pay to increase production has not been reached. But a mistake frequently made in judging how far yields may be profitably carried is to compare the receipts per cow from milk sold with the value of feed except pasture used. On this basis an increase in production of 898 pounds of milk would have resulted in increased receipts for milk sold, of $2.50 for each additional dollar spent for barn feed, a further increase of 955 pounds would have brought the same return, and the last increase of 1220 pounds would have resulted in increased receipts of $1.80 for each additional dollar's worth of feed except pasture. These figures are, respectively, 11, 50, and 25 per cent higher than when

total costs and total returns are considered, and any such method of calculation is misleading because it favors too intensive methods. All of the costs and all of the returns should be considered.

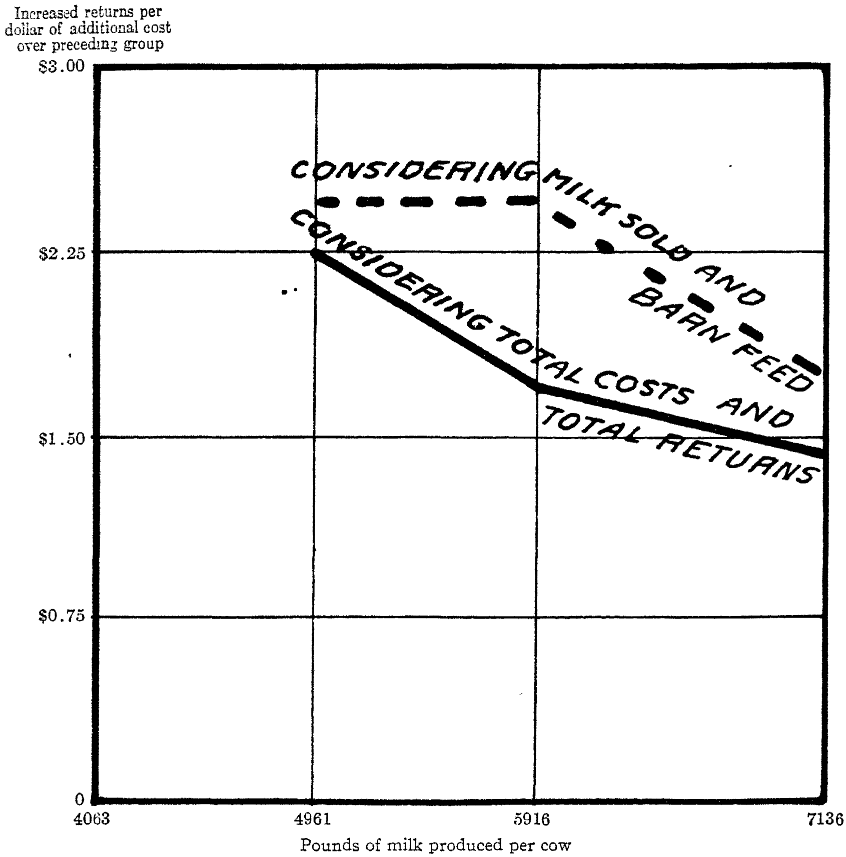


FIG. 66. CORRECT AND INCORRECT METHODS OF CALCULATING INCREASED RETURNS
The incorrect practice of considering as profit the difference between the value of barn feed and receipts from milk, favors too intensive methods. All the costs and returns should be considered

Relation of production and season of production to intensity of feeding and to costs and returns

Of the farmers getting more than 6500 pounds of milk per cow, 79 per cent fed more than 1500 pounds of grain. The average for winter dairies was about one ton per cow. When the production averaged less than 4500 pounds per cow, none of the farmers used more than 1500 pounds of grain per cow except in winter dairies, where one-fourth of the farmers exceeded this amount. With this production, 61 per cent of the farmers used less than 1000 pounds per cow. (Table 103.) The number of herds and cows in each group are given in table 105.

TABLE 103. RELATION OF PRODUCTION AND SEASON OF PRODUCTION TO INTENSITY OF FEEDING

Per cent of milk sold during May, June, and July	Pounds of milk produced per cow			
	Under 4500	4500–5500	5501–6500	Over 6500
Less than 33:				
Pounds of grain fed per cow:				
Maximum	1,700	2,309	2,777	2,939
Minimum	719	677	979	1,214
Average	1,172	1,394	1,786	2,029
Per cent feeding:				
Less than 1000 pounds of grain per cow	25	23	......	......
1000–1500 pounds	50	36	44	17
More than 1500 pounds	25	41	56	83
Value of feed except pasture per cow:				
Maximum	$58	$78	$85	$96
Minimum	$30	$36	$36	$48
Average	$48	$53	$60	$74
From 33 to 40:				
Pounds of grain fed per cow:				
Maximum	1,000	2,153	2,213	2,450
Minimum	548	593	890	974
Average	853	1,300	1,416	1,708
Per cent feeding:				
Less than 1000 pounds	88	17	5	20
1000–1500 pounds	12	50	47	......
More than 1500 pounds	......	33	48	80
Value of feed except pasture per cow:				
Maximum	$49	$78	$74	$74
Minimum	$32	$31	$31	$39
Average	$40	$48	$52	$53
More than 40:				
Pounds of grain fed per cow:				
Maximum	1,200	1,550	2,658	1,629
Minimum	429	631	673	1,169
Average	873	1,026	1,311	1,341
Per cent feeding:				
Less than 1000 pounds	50	39	40	......
1000–1500 pounds	50	50	33	50
More than 1500 pounds	......	11	27	50
Value of feed except pasture per cow:				
Maximum	$45	$62	$72	$53
Minimum	$24	$28	$32	$44
Average	$36	$39	$45	$47

The difference in cost of production and profit due to increased production up to 6500 pounds is not so striking with summer dairies as it is with winter dairies, because higher yields are more difficult to obtain with spring-fresh cows and the summer system than with fall-fresh cows. In winter dairies, increased yield from 4234 pounds to 5974 pounds per cow was accompanied by a decrease of 42 cents in the cow cost of production and a decrease in loss of $20 per cow. In summer dairies, increased production from 3988 pounds to 5815 pounds was accompanied by a decrease in cost of 31 cents and a decrease in loss of $12 per cow. (Tables 104 and 105.)

TABLE 104. RELATION OF PRODUCTION AND SEASON OF PRODUCTION TO COST OF PRODUCTION AND PROFITS

Per cent of milk sold during May, June, and July	Pounds of milk produced per cow			
	Under 4500	4500–5500	5501–6500	Over 6500
Less than 33:				
Total costs per cow	$101	$107	$118	$135
Total returns per cow	$79	$98	$116	$138
Profit or loss per cow	—$22	—$9	—$2	+$3
Per cent showing profit on cows	0	36	44	50
Herd cost of milk per hundred pounds	$2.15	$1.94	$1.76	$1.78
Cow cost of milk per hundred pounds	$2.18	$1.90	$1.76	$1.72
From 33 to 40:				
Total costs per cow	$90	$97	$106	$104
Total returns per cow	$76	$91	$107	$126
Profit or loss per cow	—$14	—$6	+$1	+$22
Per cent showing profit on cows	25	28	43	80
Herd cost of milk per hundred pounds	$1.96	$1.74	$1.60	$1.30
Cow cost of milk per hundred pounds	$2.00	$1.74	$1.59	$1.27
More than 40:				
Total costs per cow	$82	$89	$100	$114*
Total returns per cow	$71	$89	$101	$116
Profit or loss per cow	—$11	0	+$1	+$2
Per cent showing profit on cows	50	39	53	50
Herd cost of milk per hundred pounds	$1.86	$1.51	$1.51	$1.57
Cow cost of milk per hundred pounds	$1.83	$1.55	$1.52	$1.52

*Only two herds in this group.

Relation of production to value of cows

It has already been shown that cows were held at a higher value in the larger herds and when more winter milk was produced. But the factor most strikingly correlated to the value of a cow is the amount of milk she gives.

Cows in herds averaging 4063 pounds of milk had an average value of $58, while those in herds producing 7136 pounds had an average value of $75. Altho the better-producing cows were held at higher prices, it may be seen in table 105 that they produced about 25 pounds of milk more per dollar invested in them than did poor cows. To allow for as much milk production per dollar of investment as for the higher-yielding cows, it would have been necessary to value the lower producers at $43 instead of at $58 a head.

Since the relationship between season of production and value of cows, and that between production and value of cows, are so marked, it might be expected that cows in low-yielding dairies with largely summer production would be held for the least price and cows in high-yielding dairies with more intensive methods would be held at the highest figure. That this is true may be seen in table 105. It is further shown in this table that cows in summer dairies produce less milk per dollar invested than do cows

in the other herds, but good-producing cows are held at equally high values with summer production or with winter production.

TABLE 105. RELATION OF PRODUCTION AND SEASON OF PRODUCTION TO VALUE OF COWS

Per cent of milk sold during May, June, and July	Pounds of milk produced per cow: Under 4500	4500–5500	5501–6500	Over 6500	Average	Pounds of milk produced per $1 in value	Value of cows per hundredweight of milk produced
Less than 33:							
Number of farms	4	22	18	12	......	....	....
Number of cows	50.5	290.5	251.5	205 5	......	....	....
Value per cow	$60	$64	$62	$77	$67	....	$1.15
Pounds of milk produced	4,234	5,003	5,974	7,184	5,822	87	....
From 33 to 40:							
Number of farms	8	18	21	5	......	....	....
Number of cows	125.5	242.5	326.0	63.0	......	....	....
Value per cow	$61	$59	$65	$69	$63	....	$1.16
Pounds of milk produced	4,029	4,978	5,935	7,133	5,412	86	....
More than 40:							
Number of farms	6	18	15	2	.....	....	....
Number of cows	50.0	213.0	205 5	25.5	......	....	....
Value per cow	$51	$64	$68	$75	$65	....	$1.24
Pounds of milk produced	3,988	4,885	5,815	6,761	5,255	81	....
Average production per cow	4,063	4,961	5,916	7,136	5,532	....	....
Average value of cows per head	$58	$63	$65	$75	$65	....	....
Pounds of milk produced per $1 in value of cows	70	79	91	95	......	86	....
Value per hundredweight of milk produced	$1.43	$1.26	$1.10	$1.05	......	....	$1.17

Combined effect of size of herd, season of production, and production per cow, on costs and returns

The highest cost of production and the largest losses are in the small, low-producing herds, making a large share of their product in winter; while the lowest cost of production and the largest gains are made in the large, high-producing herds, making a large proportion of milk in summer. This at once emphasizes the importance of seeking an adjustment in all three of these factors if one would expect the greatest returns from his dairy.

Some dairies do well in spite of the handicap of a small herd, in spite of poor cows, or in spite of the fact that the system is not of the proper intensity for the greatest profits under the conditions. With a large herd one may make a profit on lower-producing cows. When the cows are unusually good, it is possible to succeed well with a smaller number. If the system is one that depends largely on cheap pasture, it may pay even tho the farmer is not fully employed thruout the winter. But it is extremely difficult to make a dairy pay well under all of these handicaps. If the herd is small and the cows are poor, increasing the numbers may result in greater loss. If it is desired to change to a more intensive system, the cows may be too poor to make a profit on costly winter feed. Thus it is evident that one cannot afford to disregard the

close interrelation of all points of the business. Matters of herd improvement should always receive much attention. But if one is to expect the greatest returns from the use of better stock, it is necessary that he should work with reasonably large numbers. When one has a large herd of high-class cattle, he can little afford to use extensive methods in their feeding and care.

The data on relation of size of herd, season of production, and production per cow, to cost of production and profits, are given in table 106:

TABLE 106. RELATION OF SIZE OF HERD, SEASON OF PRODUCTION, AND PRODUCTION PER COW, TO COST OF PRODUCTION AND PROFITS

Per cent of milk sold during May, June, and July	Pounds of milk produced per cow					
	Under 5000		5000–6000		Over 6000	
	Number of cows per farm					
	Less than 15	15 or more	Less than 15	15 or more	Less than 15	15 or more
Less than 33:						
Number of farms	10	5	12	8	13	8
Cows per farm	10.6	16.3	10.0	20.0	9.9	25.2
Total cost per cow	$106	$110	$116	$103	$135	$126
Total returns per cow	$88	$93	$108	$104	$127	$134
Profit or loss per cow	—$18	—$17	—$8	+$1	—$8	+$8
Herd cost of milk per hundred pounds	$2.12	$2.15	$1.89	$1.75	$1.88	$1.69
Cow cost of milk per hundred pounds	$2.11	$2.10	$1.90	$1.67	$1.84	$1.65
From 33 to 40:						
Number of farms	14	4	10	9	8	7
Cows per farm	10.9	19.5	10.8	21.8	10.1	20.2
Total cost per cow	$98	$91	$111	$93	$108	$108
Total returns per cow	$85	$75	$98	$97	$115	$117
Profit or loss per cow	—$13	—$16	—$13	+$4	+$7	+$9
Herd cost of milk per hundred pounds	$1.93	$1.95	$1.91	$1.50	$1.51	$1.45
Cow cost of milk per hundred pounds	$1.94	$2.02	$1.87	$1.50	$1.47	$1.45
More than 40:						
Number of farms	16	3	11	7	3	Only one farm in this group
Cows per farm	9.7	18.0	10.7	17.9	11.7	
Total cost per cow	$86	$91	$104	$85	$124	
Total returns per cow	$80	$82	$98	$100	$114	
Profit or loss per cow	—$6	—$9	—$6	+$15	—$10	
Herd cost of milk per hundred pounds	$1.71	$1.67	$1.68	$1.21	$1.65	
Cow cost of milk per hundred pounds	$1.70	$1.75	$1.66	$1.24	$1.72	

Butterfat test of milk

With one exception, all the companies included in this study tested the milk delivered by each patron two or three times monthly. These tests were made from composite samples kept from daily deliveries. The test for the month as reported to the dairymen was an average of these samples.

This average test for each month of the year was obtained from the companies' records for each of 114 farms. For the remaining 35 farms no data as to the test for various months were obtainable. In order not to include any estimates on this part of the work, these records were omitted from the tabulations concerning test of milk.

The amount of butterfat sold each month was calculated for each of the 114 farms by multiplying the number of pounds of milk sold by the average test for the month. An estimated average test for the year was

used in calculating the fat in the small quantities of milk retailed. The total number of pounds of fat in the milk sold was then divided by the number of pounds of milk sold to determine the average butterfat test for the year. In other parts of the work it has been assumed that the milk from the 35 farms tested the same as that from the 114 farms.

Variation in test

The average test for the year varied from 3.5 per cent to 4.8 per cent. There were three herds that averaged 3.5 per cent and five herds that averaged over 4.5 per cent. The average test for all herds was 4 per cent for the year.

The monthly variation in the test of milk was greater when a large proportion of the milk was produced in summer. Probably this was partly

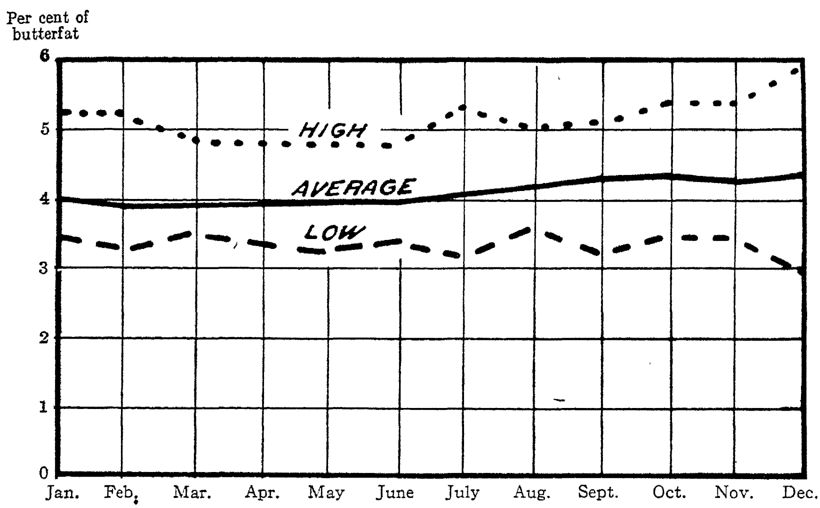


FIG. 67. MAXIMUM, MINIMUM, AND AVERAGE MONTHLY BUTTERFAT TESTS

because more of the cows came fresh at about the same time and dried off together.

The curve for the group of herds producing summer milk (fig. 68) shows the effect of advance in lactation period on the fat content of the milk. If it is assumed that on the average the cows in this group freshened on April 1, then the increase in the percentage of butterfat in the milk would be 0.7 per cent in nine months. This would be more of a relation between the number of days in milk and the fat content than Eckles found for twenty Jersey cows giving richer milk.[11] Since not all the cows in this group freshened in April, there is probably even more relation in these herds between the stage of lactation and the percentage of fat in the milk than the figures indicate.

[11] *Dairy Farming* (Eckles and Warren), page 69.

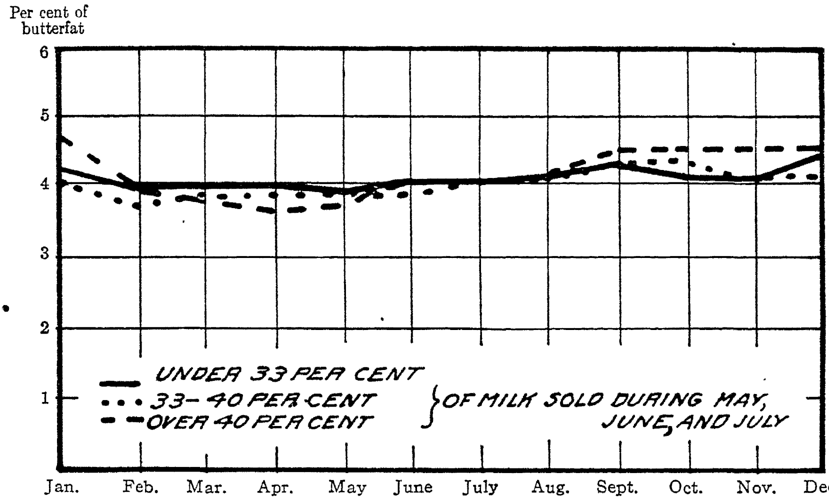


FIG. 68. RELATION OF SEASON OF MILK PRODUCTION TO MONTHLY BUTTERFAT TEST OF MILK

The milk from herds following the summer system tested lower in the spring months and higher in the winter months than that from herds following a more intensive system. In summer the test was about the same for the two systems

Relation of test of milk to production

There was little difference in the relative amount of milk produced in summer by herds producing milk of different butterfat content. The average milk production in the herds that tested less than 3.8 per cent was 5844 pounds per cow; in those that tested from 3.8 to 4 per cent it was 5495 pounds; in those testing from 4.1 to 4.2 per cent it was 5092 pounds; and in those testing more than 4.2 per cent it was 5271 pounds. (Table 107.)

TABLE 107. RELATION OF TEST OF MILK TO PRODUCTION AND SEASON OF PRODUCTION ON 114 FARMS REPORTING BUTTERFAT TEST BY MONTHS

Per cent of butterfat in milk	Average per cent of butterfat	Number of farms	Number of cows	Number of cows per farm	Pounds of milk: Produced per cow	Pounds of milk: Sold per cow	Pounds of fat in milk sold per cow	Per cent of milk sold during May, June, and July
Less than 3.8	3.6	13	167.0	12.8	5,844	5,313	193	31
From 3.8 to 4.0	3.9	46	663.5	14.4	5,495	5,028	196	34
From 4.1 to 4.2	4.1	26	299.0	11.5	5,092	4,662	193	36
More than 4.2	4.4	29	343.0	11.8	5,271	4,782	210	34
Total	......	114	1,472.5	......	......	......	....	....
Average	4.0	......	......	12.9	5,400	4,929	198	34

Relation of test of milk to costs and returns

The total cost and the returns per cow were higher in the low-testing than in the high-testing herds. The returns just equaled the costs in the case of herds testing the least. In the higher-testing herds there was a loss of from $4 to $8 on each cow. (Table 108.)

TABLE 108. RELATION OF TEST OF MILK TO COSTS AND RETURNS ON 114 FARMS REPORTING BUTTERFAT TEST BY MONTHS

Per cent of butterfat in milk	Total cost per cow	Receipts per cow from milk sold	Total returns per cow	Profit or loss per cow	Herd cost of milk per 100 pounds	Cow cost of milk per 100 pounds	Per cent of herds showing profit on cows
Less than 3.8	$110	$90	$110	0	$1.71	$1.69	46
From 3.8 to 4.0	108	81	101	—$7	1.77	1.75	39
From 4.1 to 4.2	103	75	95	— 8	1.77	1.78	23
More than 4.2	105	81	101	— 4	1.80	1.77	45
Average	$106	$81	$101	—$5	$1.77	$1.75	38

The cost of producing milk rich in butterfat was more than for that with a lower test. The herd cost of producing milk that tested 3.6 per cent butterfat was $1.71; the cow cost was $1.69 per hundredweight. But the herd cost of producing milk that tested 4.4 per cent of butterfat was $1.80 and the cow cost was $1.77 per hundredweight. Since the range of variation in the butterfat test of milk was not wide, the difference in the cost between groups was less than if there had been more variation in the richness of the milk.

Comparison of hill and valley farms

Of the 99 hill dairies, 40 had less than twelve cows, 43 had from twelve to eighteen cows, and 16 had more than eighteen cows. Among the 50 valley farms there were 23 with less than twelve cows, 14 with from twelve to eighteen cows, and 13 with more than eighteen cows.

Location

So far as markets, soil, and growing season are concerned, hill farms are less favorably located for almost any profitable type of farming than are valley farms. With the exception of sixteen dairymen who sold to the milk station at Tunnel, all the dairymen on these farms sold their milk to stations located in the valleys. Twelve of the hill farms were more than 8.5 miles from the milk station, but none of the valley farms were at this distance.

The average distance to the milk stations was 4.4 miles from the 99 hill farms and 3.1 miles from the 50 valley farms, a difference of 1.3 miles, or 2.6 miles for each trip with milk or to get feed. In addition, the roads to the hills are steep. Valley farms are thus more accessible to milk stations, railroads, feed mills, and towns. Hence the cost of delivering milk to market for the hill farms is greater. Even tho many of the hill dairymen hired their milk hauled, the cost per hundredweight averaged 22 cents as against 13 cents for the valley farms. The cost of hauling feed to be ground and of hauling feed purchased is also higher.

The elevation of the hill farms varied from 850 to about 1800 feet, while that of the valleys ranged from about 800 to about 900 feet. This

gives the valley farms an advantage in the production of practically all farm crops. On the hills 9.3 acres were farmed, of which 3.2 acres were pastured for each cattle unit kept; while in the valleys 7.8 acres were farmed, of which 2.6 acres were pastured for each cattle unit kept. The upland pastures suffer more from drought than do the pastures nearer the valleys, and do not hold grass well. As a consequence, more land is required to furnish summer feed for an animal. This, together with the fact that the land is more hilly and farther from market, makes it worth less per acre. The cost of pasture per animal is less on the hills.

The average value of pasture land on the hill farms was $15 an acre, while on the valley farms it was $32 an acre. In view of this, the pasture costs were $3.71 per cow on the hills and $6.02 per cow in the valleys. The valley crop land is more productive, which allows the keeping of more stock there during the winter. Therefore the hill farms are not so heavily stocked.

Size of dairy business

On the hill farms an average of 13.3 cows were kept on 158 acres, of which 54 acres were pastured (table 109). The largest of these farms comprised 700 acres and kept fifteen cows and thirteen heifers. Nine farms

TABLE 109. COMPARISON OF HILL AND VALLEY DAIRIES AS TO SIZE OF THE DAIRY BUSINESS

	Number of cows per farm							
	Under 12		12–18		Over 18		Average	
	Hill	Valley	Hill	Valley	Hill	Valley	Hill	Valley
Number of farms	40	23	43	14	16	13	99	50
Acres farmed	130	94	168	135	205	279	158	153
Acres pastured	41	26	59	48	76	97	54	51
Average miles to milk station	4.8	3.6	3.9	3.4	4.5	1.9	4.4	3.1
Number of cows	9.0	8.7	14.3	14.9	21.8	25.2	13.3	14.7
Number of heifers	4.7	4.7	6.6	7.2	7.4	15.7	6.0	8.2
Cattle units	11.9	11.6	18.4	19.5	26.4	34.1	17.0	19.7
Hundredweight of milk sold	447	401	704	730	1,115	1,485	667	775
Receipts from milk sold	$719	$668	$1,137	$1,203	$1,810	$2,519	$1,077	$1,299
Acres per cattle unit	10.9	8.1	9.1	6.9	7.8	8.2	9.3	7.8
Value of pasture land per acre	$15	$41	$15	$39	$14	$24	$15	$32

kept less than eight cows, the smallest number being six. Of these, four contained from 37 to 92 acres, and five contained from 104 to 200 acres. On each of eight hill farms containing from 130 to 339 acres, more than twenty cows were kept. The largest of these herds contained thirty cows, on a 280-acre farm, from which 1456 hundredweight of milk was sold for $2390. On the average 667 hundredweight of milk, returning $1077, was sold per hill farm. The largest total receipts for milk sold from a hill farm was $2738 from 26.5 cows. Five farms each sold less than $500 worth of milk.

On the valley farms an average of 14.7 cows were kept on 153 acres, of which 51 acres were pastured. The largest valley farm comprised 800 acres and kept thirty cows and thirty-one heifers. On this farm were 250 acres of hill pasture and a still larger acreage of woods, not pastured. Since the valleys are usually narrow, many farms classified in this study as valley farms have some steep hillside in pasture or in woods. Any farm that had bottom land in one of the three valleys mentioned was called a valley farm.

Seven valley farms kept less than eight cows, the smallest number being 6.5. More than twenty cows were kept on each of eleven farms. These farms comprised from 125 to 800 acres. The largest herd was thirty-seven cows, from which 2661 hundredweight of milk was sold for $4889. This was the highest return from milk on any farm. There were three herds with thirty or more cows.

An average of 775 hundredweight of milk, returning $1299, was sold from the valley farms. Seven valley farms received less than $500 per farm from milk sold. With one exception these were small farms of from 40 to 80 acres. Some of them grew light truck crops for local markets; others depended almost exclusively on the dairy for their income.

Altho the enterprise is larger on the valley farms than on the hill farms, because more cows are kept on the former, the facts that on valley farms a greater proportion of the milk was produced during winter when milk prices are higher, and that cows on these farms are more heavily fed than are cows on the hill farms, largely account for the greater returns from the valley dairies.

Season of production

Most of the hill farms follow the summer system. While some valley herds are primarily summer dairies, in general they follow a more intensive system. This is influenced largely by the amount of crop work done, the distance to market, the growing season, and the productivity of the soil. On the average, the 99 hill farms produced during May, June, and July 36 per cent of their total pounds of milk sold for the year. This figure for the 50 valley farms was 31 per cent.

The per cent of the total pounds produced during November, December, January, and February, was 25 for the hill farms and 29 for the valley farms. Receipts from milk sold differed even more.

Production

The production per cow is better on the valley farms, especially in the larger herds. Since, as has been shown, the tendency is to produce more milk in winter and to feed heavier in the valleys, this is to be expected. On the average, 4994 pounds were sold per cow on the hills and 5260 pounds in the valleys, or about 266 pounds more per cow on the valley farms. For every dollar's worth of feed consumed, the milk sold from the

hills exceeded that from the valleys by ten pounds per cow. Hence, cows on hill farms are as good producers as those in the valleys, especially when relative values are considered. Particularly in the larger herds, the returns per cow from milk sold are greater in the valleys. Some of this is due to heavier yields, but more is due to the higher prices that prevail in winter. On hill farms the average receipts per cow from milk sold varied from $41 to $129, the average being $81; and on the valley farms the highest receipts from milk sold were $157 per cow, the lowest were $44, and the average was $88.

Comparisons of hill and valley farms in relation to various factors are shown in tables 110 to 112.

TABLE 110. COMPARISON OF HILL AND VALLEY DAIRIES AS TO INTENSITY OF FEEDING

	Number of cows per farm							
	Under 12		12–18		Over 18		Average	
	Hill	Valley	Hill	Valley	Hill	Valley	Hill	Valley
Pounds of grain fed per cow:								
Summer	99	78	163	53	155	198	144	124
Winter	1,261	1,208	1,172	1,516	1,248	1,372	1,216	1,368
Pounds of silage fed per cow	2,980	1,912	2,982	2,355	3,765	8,258	3,188	4,858
Pounds of other succulent feed per cow	570	1,259	788	545	927	587	770	1,020
Pounds of dry forage per cow	4,429	4,947	4,322	4,731	3,281	3,666	4,076	4,316
Per cent of farms feeding:								
Less than 1000 pounds of grain per cow	20	30	28	14	19	23	23	24
From 1000 to 1500 pounds of grain per cow	48	35	37	43	31	23	40	34
More than 1500 pounds of grain per cow	32	35	35	43	50	54	36	42
Profit or loss per cow when:								
Less than 1000 pounds were fed per cow	—$4	+$3	—$10	+$5	+$11	+$7	—$4	+$5
From 1000 to 1500 pounds were fed per cow	—$10	—$8	—$2	—$4	+$15	+$5	—$1	—$3
More than 1500 pounds were fed per cow	—$13	—$21	—$4	—$2	+$1	+$1	—$5	—$6
Per cent feeding silage	40	26	49	43	62	77	47	44

TABLE 111. COMPARISON OF HILL AND VALLEY DAIRIES AS TO COST OF PRODUCING MILK AND AS TO PROFIT OR LOSS ON CATTLE

	Number of cows per farm							
	Under 12		12–18		Over 18		Average	
	Hill	Valley	Hill	Valley	Hill	Valley	Hill	Valley
Herd cost per hundred pounds of milk	$ 1.81	$ 1.93	$ 1.71	$ 1.88	$ 1.45	$ 1.63	$ 1.67	$ 1.77
Cow cost per hundred pounds of milk	1.80	1.88	1.71	1.82	1.48	1.60	1.67	1.72
Price received per hundred pounds of milk sold	1.61	1.67	1.61	1.65	1.62	1.70	1.62	1.68
Profit or loss on cows per farm	— 86	— 86	— 71	—126	+162	+145	— 40	— 37
Total costs per cow	110	109	103	109	94	113	102	111
Total returns per cow	100	99	98	100	101	119	99	108
Profit or loss on cows per cow	— 10	— 10	— 5	— 9	+7	+ 6	— 3	— 3
Profit or loss on cattle per farm	— 91	—107	— 66	—170	+198	+ 93	— 33	— 73

Cattle on the valley farms are given higher values than are cattle on the hill farms. This may be because the cows are larger, are better producers, are nearer the market, freshen in the fall, or are not kept in the herd so long. The average value of cows on the hill farms was \$63 a head, and of heifers \$22 a head. On the valley farms the value of cows was \$68, and of heifers \$26, a head. The average value at time of freshening of heifers that dropped their first calf during the year was \$56 for the hill farms and \$57 for the valley farms.

In all, 39 herds used purebred bulls. Of these, 22 were on hill farms and 17 were on valley farms. The proportion of farms using purebred bulls is greater in the valleys, and particularly so in the larger herds. Of the hill farms 22 per cent, and of the valley farms 34 per cent, used purebred bulls. Cows are replaced more frequently in the valley herds.

TABLE 112. COMPARISON OF HILL AND VALLEY DAIRIES AS TO MISCELLANEOUS FACTORS

	Number of cows per farm							
	Under 12		12–18		Over 18		Average	
	Hill	Valley	Hill	Valley	Hill	Valley	Hill	Valley
Cost of hauling milk per hundredweight	\$0.26	\$0.16	\$0.25	\$0.11	\$0.14	\$0.12	\$0.22	\$0.13
Building investment per cattle unit	\$58	\$57	\$56	\$49	\$46	\$58	\$54	\$55
Building costs per cow	\$6	\$7	\$5	\$5	\$5	\$6	\$5	\$6
Average years cow remains in herd	7.8	7.8	7.5	6.8	6.9	7.5	7.5	7.4
Number of farms using pure-bred bulls	7	2	9	6	6	9	22	17
Per cent of farms using purebred bulls	18	9	21	43	38	69	22	34
Value of cows per head	\$64	\$65	\$62	\$65	\$64	\$72	\$63	\$68
Value of heifers per head	\$19	\$22	\$22	\$23	\$27	\$30	\$22	\$26
Value of heifers that became cows, per head	\$55	\$55	\$55	\$47	\$63	\$62	\$56	\$57
Number of heifers that became cows, per 100 cows	15.6	17.9	12.0	14.9	12.3	19.5	13.1	17.8

The primary purpose in comparing hill and valley farms is to emphasize the effect of location on practices. Conditions on the uplands, such as poor soil, higher elevation, rougher topography, and the longer distance to market, do not allow so intensive a system to be profitably conducted as is possible in the valleys. Whenever recommendations are made to farmers, or before one decides to locate in a section of so diverse characteristics, these fundamental facts should be given due consideration. They materially affect the system of farming.

Cow-testing-association herds

In 20 of the 149 herds, containing 394 cows, cow-testing-association work was being done by the Susquehanna Valley and Killawog cow testing associations. Most of these herds were on valley farms. With 19.7 cows to the farm, they were about half as large again as the average herd.

The average quantity of grain fed in these 20 herds was 1485 pounds per cow, of silage 6194 pounds, of other succulent feed 1070 pounds, and of dry forage 4034 pounds (table 113). Altho but 78 pounds of grain more than the average was fed, the quantity of silage used was nearly double

TABLE 113. Amounts of Feed Used, Labor Required, and Other Quantities, for 394 Cows in 20 Cow-Testing-Association Herds

	Amounts		
	Total	Per cow	Per 100 pounds of milk produced
Number of farms	20	...	...
Number of cows	394	...	...
Number of heifers	240	...	...
Value of cows	$26,183	$66.45	...
Value of heifers	$6,925	$28.85	...
Grain fed	5,850 cwt.	1,485 pounds	25.6 pounds
Silage fed	1,220.2 tons	6,194 pounds	107.0 pounds
Other succulent feed	210.7 tons	1,070 pounds	18.5 pounds
Dry forage fed	794.67 tons	4,034 pounds	69.7 pounds
Human labor (except hauling milk)	63,638 hours	162 hours	2.79 hours
Milk sold	21,324 cwt.	5,412 pounds	...
Milk produced	22,804 cwt.	5,788 pounds	...
Purebred bulls	16	...	...
Per cent of farms using purebred bulls	80	...	...

the average. The value of feed used per cow was $63.80, as compared with the average of $56.10 (table 114). Thus, in general, the feeding was heavier. The average time spent was 162 hours per cow. This is fifteen hours more per cow than for the nearest-sized group. The cows had an average valuation of $66 a head and produced 5788 pounds of milk, of which 5412 pounds were sold. This yield is 256 pounds more than the average for all cows in the study. Of the 20 herds, 80 per cent used purebred bulls.

The costs per cow averaged $109.46 for the herds in the associations. This is about $6 per cow more than the average for all herds. The costs other than feed, however, were about $1 less per cow than for the average herd.

The returns in association herds were $106.67 per cow, or about $6 more than the average. The loss was $2.79 per cow, or about the same as the average.

The herd cost of milk for the twenty herds was $1.74 per hundredweight and the cow cost $1.71 per hundredweight, or 4 cents and 2 cents, respectively, higher than the average cost of milk production, but 10 cents less than the cost in winter dairies.

TABLE 114. COSTS AND RETURNS FOR 394 COWS IN 20 COW-TESTING-ASSOCIATION HERDS

Items	Value	
	Total	Per cow
Costs:		
Grain	$9,030.00	$22.92
Silage	6,103.00	15.49
Other succulent feed	698.00	1 77
Dry forage	7,591.00	19.27
Pasture	1,714.00	4.35
Bedding	291.00	0.74
Human labor	9,225.35	23.41
Horse labor	364.50	0.93
Use of buildings	1,723.28	4.37
Use of equipment	158.90	0.40
Interest on stock	1,309.15	3.32
Interest on feed	333.00	0.85
Bull service	488.84	1.24
Miscellaneous items	798.00	2.03
Hauling milk	3,299.17	8.37
Total costs	$43,127.19	$109.46
Returns:		
Milk sold	$35,319.60	$89.64
Milk and its products used	2,406.33	6.11
Increase on cows*	312.00	0.79
Manure	3,991.74	10.13
Total returns	$42,029.67	$106.67
Loss	$1,097.52	$2.79
Herd cost of milk	$37,020.04	$1.74 per cwt.
Cow cost of milk	$36,417.12	$1.71 per cwt.

*Value of calves at birth above depreciation on cows.

A still better comparison is to contrast the averages for these herds with the figures for all herds containing more than 18 cows and averaging 23.3 cows. The most striking points brought out by such a comparison are that the costs other than for feed for the cow-testing-association herds, and the returns, were approximately the same as for the nearest-sized group. But the association herds used feed valued at $9 more per cow and the production was 65 pounds less per cow. There was a loss of $3 per cow in association herds, while the average gain for herds with more than 18 cows was $7 per cow.

The facts that in association herds the cows were held at a higher price, that production was better, that better bulls were used, and that the feeding was heavier, show that a more intensive system of dairying than the average was followed with these herds. In organizing an association, especial effort is made to induce dairymen with the larger herds to join, in order to finance the undertaking. Hence the mere fact that these dairy-

men joined associations is evidence that they were using unusual methods or had herds larger than common. This is probably true of most herds doing cow-testing-association work elsewhere in the State. Thus, results from cow-testing-association work should not be taken as an indication of the average cost of milk production for any region.

Milk hauling

Two important factors affecting the cost of delivering milk to the station are the method of hauling, and the distance to the station. Common ways of getting milk from the farm to the station are for dairymen (1) to haul their own milk only, (2) to cooperate with one or more neighbors in hauling, (3) to hire their milk hauled, or (4) to use a combination of these methods. The number using each method is given in table 115, and data on the labor required and the cost of hauling by the different methods are given in tables 116 and 117.

TABLE 115. METHODS USED BY 149 DAIRYMEN IN DELIVERING MILK TO MARKET, AND NUMBER USING EACH METHOD

Method	Number using
Hauling	44
Cooperating in hauling	15
Hiring milk hauled	62
Hauling part distance full time, hiring remainder	13
Hauling part distance full time, cooperating remainder	1
Hauling full distance part time, hiring remainder	8
Hauling full distance part time, cooperating remainder	2
Using three methods, full distance, part time each	1
Hiring full distance part time and cooperating full distance part time	2
Cooperating part distance thruout and hiring part distance thruout	1
	149

Hauling own milk only.— On the average, 356 trips with a load of 240 pounds of milk worth $3.99 were made per farm by farmers who hauled their own milk thruout the season. The average distance from these farms to market was 1.8 miles. On six farms women made some of the trips, on four farms boys made some, and on two farms girls made some. In all cases men made at least half the trips. The average time spent was 1.7 human hours and 2.2 horse hours per trip. The average cost of hauling was 23 cents per hundredweight, or $12.53 per cow. This charge represented 14 per cent of the money received for the milk, 11 per cent of the average cost of keeping a cow on these farms, or 13 per cent of the cost of producing and marketing the milk. As the distance hauled increased, the time spent per trip, and therefore the cost of hauling, also increased.

Cooperating in hauling.— Fifteen farmers cooperated with one or more of their neighbors in hauling their milk. Altho on the average these farmers

TABLE 116. LABOR REQUIRED IN HAULING MILK VARIOUS DISTANCES BY DIFFERENT METHODS

	Average distance hauled (miles)	Number of farms	Trips per farm	Human hours per trip	Horse hours per trip	Human hours per 100 pounds of milk sold	Horse hours per 100 pounds of milk sold	Farms using woman or child labor	Farms using man labor	Hundred-weight of own milk hauled per load
When dairymen hauled										
1 mile or less	0.8	15	352	1.1	1.6	0.44	0.65	3	15	2.4
1+ to 2+ miles	1.9	22	365	1.8	2.3	0.79	1.02	7	22	2.3
3 to 4+ miles	3.5	6	349	2.1	2.3	0.71	0.78	2	6	2.9
5 miles or more	5.0	1	245	5.0	10.0	1.84	3.68	0	1	2.7
Total	....	44	....	....	....	....	....	12	44	....
Average	1.8	....	356	1.7	2.2	0.68	0.90	....	....	2.4
When dairymen cooperated in hauling										
1 mile or less	1.0	3	183	1.3	2.5	0.31	0.58	1	3	4.3
1+ to 2+ miles	2.0	4	180	2.4	4.8	0.50	1.00	....	4	4.8
3 to 4+ miles	3.9	5	96	3.2	6.3	0.56	1.12	....	5	5.6
5 miles or more	5.3	3	42	5.4	10.9	0.46	0.91	....	3	11.9
Total	....	15	....	....	....	....	....	1	15	....
Average	3.1	....	125	2.5	4.9	0.46	0.92	....	....	5.4
When dairymen hauled part of the way and hired remaining distance	0.8	13	365	0.8	1.1	0.53*	0.68*	2	12	1.6

* Farmers' own time only.

TABLE 117. Cost of Hauling Milk Various Distances by Different Methods

	Average distance hauled (miles)	Average distance hired hauled (miles)	Number of farms	Number of cows per farm	Pounds of milk sold per cow	Per cent of milk sold during May, June, and July	Cost of milk hauling: Per cow	Cost of milk hauling: Per 100 pounds of milk sold	Cost of producing milk per 100 pounds sold	Per cent of value of milk sold, represented by cost of milk hauling
When dairymen hauled										
1 mile or less	0.8	....	15	15.5	5,492	33	$ 8.81	$0.160	$1.68	10
1+ to 2+ miles	1.9	....	22	15.4	5,476	33	14.38	0.263	1.75	16
3 to 4+ miles	3.5	....	6	18.2	5,590	37	11.51	0.206	1.64	12
5 miles or more	5.0	....	1	16.5	4,030	49	33.41	0.830	2.26	53
Total	....	....	44	....	....	....	....	....	....	....
Average	1.8	....	....	15.8	5,465	34	$12.53	$0.230	1.72	14
When dairymen cooperated in hauling										
1 mile or less	1.0	....	3	17.3	4,550	31	$ 5.97	$0.131	$1.52	8
1+ to 2+ miles	2.0	....	4	15.4	5,593	25	12.56	0.225	1.72	13
3 to 4+ miles	3.9	....	5	12.2	4,431	42	11.21	0.253	1.59	16
5 miles or more	5.3	....	3	10.8	4,658	43	9.55	0.205	1.44	13
Total	....	....	15	....	....	....	....	....	....	....
Average	3.1	....	....	13.8	4,842	34	$10.03	$0.207	$1.60	13
When dairymen hired milk hauled										
1 mile or less	....	0.9	4	15.0	5,043	33	$2.57	$0.051	$1.63	3
1+ to 2+ miles	....	2.0	6	11.2	4,666	34	3.01	0.065	1.81	4
3 to 4+ miles	....	3.7	20	13.5	4,520	38	4.63	0.102	1.55	6
5 miles or more	....	7.1	32	12.0	5,140	33	5.78	0.112	1.72	7
Total	....	....	62	....	....	....	....	....	....	....
Average	....	5.1	....	12.6	4,877	35	$4.89	$0.100	$1.66	6
When dairymen hauled part of the way and hired remaining distance	0.8	5.8	13	12.6	4,598	....	$12.83	$0.279	$1.86	17
				Farmers' time			8.19	0.178		
				Cash paid			4.64	0.101		

lived 1.3 miles farther from market, which required 0.8 hour of human time and 2.7 hours of horse time additional to make a trip, the fact that they made 231 less trips per farm and hauled larger loads permitted of more economical hauling. The number of dairymen working together increased as the distance hauled increased.

Hiring milk hauled.— Sixty-two farmers hired their milk hauled thruout. On the average, milk was sent 361 days an average distance of 5.1 miles, nearly three times as far as those hauling their own milk hauled it; while the average cost of hauling was only 10 cents per hundred pounds, or $4.89 per cow, less than half as much.

Hauling milk part distance and hiring remaining distance thruout the season.— Of the various combinations of the three methods, the commonest was for the dairyman to haul his milk part of the way, to a platform, and then hire it hauled the remaining distance to the station. In many cases this short haul was necessitated because the farm was located on a cross-road back from the main highway. The average distance that thirteen dairymen who used this method hauled their milk was 0.8 mile, and the average distance they hired it hauled was 5.8 miles. The labor cost of hauling the 0.8 mile was 17.8 cents per hundred pounds, while the amount paid to have the milk hauled 5.8 miles was only 10 cents per hundred pounds. If these thirteen farms had been located on collecting routes or on main highways, nearly all the time spent in making short hauls to platforms would have been saved. At the rates charged, this amounted to $1338, or about $103 per farm. This is 5 per cent on $2060 per farm or on $16 per acre.

If, when the farmer hauls or cooperates in hauling his milk, man labor is worth 15 cents an hour, woman or child labor 10 cents an hour, and horse labor 15 cents an hour, the rates here used, then the cheapest method of marketing milk is to hire it drawn. Studies have shown the same to be true in other regions when some of the labor was charged at lower rates. The important reason for this is that, by hauling full loads, men may make wages hauling milk long distances for a reasonable charge. Time taken to get ready, to hitch, and to unhitch, time lost on the road, and time lost in waiting at the station, when this time is worth average wages, makes the cost of a special trip with the product of a single herd very expensive. This is especially true when the herds are small.

By cooperating, thereby reducing the number of trips, many farmers could keep their marketing costs more reasonable. For some an adjustment in the size of the business or in the system of farming, so as to provide more productive work especially between morning and night chores, would make it more economical for them to hire their milk hauled rather than to haul it themselves. This is particularly true for those farther from market. The ideal type of dairy farming would be one which kept men and horses

fully employed between milkings at productive work, and which allowed each district to hire its milk hauled.

PART III. CONCERNING HEIFERS

Near New York City, where purchased feed, hay, labor, and milk are usually higher in price, and in dairy sections of the State where more of the land is suited for crop growing, fewer heifers are raised. This is because heifers can be most cheaply raised in regions that have an abundance of cheap pasture land and cheap hay. Many of the herds supplying milk for Rochester and Niagara Falls markets, and some for the Buffalo market, are replaced almost entirely by purchase, as there is less pasture land in those sections. The southern-tier counties, of which Broome County is one, have an abundance of cheap pasture and receive less for milk than do counties nearer New York. Hay also sells for less. Hence, conditions for raising dairy cattle are more favorable there.

Of the 149 farms, 146 raised heifers. The other 3 replaced their herds entirely by purchase.

The costs and returns for heifers of different ages were not kept separate. Therefore the relative costs of heifers for the first and second years were not found.

On 25 farms, 54 heifer calves under one year were lost by death. The death rate was 10 per cent of the average number inventoried, or 7 per cent of the number started.

Six heifers one year old or older died during the year. This is 1.3 per cent of the average inventory. Including the hide of one heifer slaughtered on the farm, seven hides were sold from five farms for $37. Of heifers of all ages, there were 244 more on hand at the end of the year than at the beginning. There were 125 more heifers sold than purchased. Together with the 304 heifers that came into milk, the net number of heifers for the year above those on hand and those purchased was 673, or 32.7 per hundred cows.

Amounts of feed used and labor required

The average number of heifers was 1002. Two heifers were considered one cattle unit. But since the number was averaged for each record from the inventory, the number of cattle units totals 502.7.

The average age at which heifers freshened was not found. The quantities used, the costs, and the returns are for all heifers on hand during the year. The figures per cattle unit may be considered the approximate cost of raising a heifer to two years of age.

The average amounts of feed and labor used are given in table 118.

Feed

The details as to amounts, cost, and number of farms using each of the different kinds of feed used by heifers are given in tables 1 to 3 (pages 280 to 284).

TABLE 118. AMOUNTS OF FEED USED, LABOR REQUIRED, AND OTHER QUANTITIES, FOR HEIFERS

	Total	Per cattle unit	Per head	Number of farms using
Number of farms	146	....	......	....
Average number of heifers	1,002	....	......	....
Average cattle units of heifers	502.7	....	......	....
Pounds of whole milk	215,464	429	215	134
Pounds of skimmilk:				
Separated on farm	96,068	191	96	32
Purchased	37,375	74	37	21
Pounds of buttermilk	1,300	3	1	3
Pounds of grain	267,116	531	267	139
Silage	310.1 tons	*1,234 pounds	619	45
Other succulent feed	25.25 tons	100 pounds	50	11
Dry forage	806.1 tons	3,207 pounds	1,609	138
Days on pasture	17,818	†146	......	122
Hours of human labor:				
Summer	4,696	9.3	4.7	75
Winter	23,038	45.8	23.0	142
Hours of horse labor	1,259	2.5	1.3	49
Average value of heifers	$23,626	$47.00	$23.58	....

*392.5 heifers were fed silage. This is 1580 pounds each.
† Per farm pasturing.

Whole milk.— About 108 tons of whole milk was fed to heifers on 134 farms. This is an average of 429 pounds per cattle unit, or about 375 pounds per heifer under one year old on hand at the end of the year.

Skimmilk.— On 32 farms, 48 tons of skimmilk separated on the farms was fed to heifers. Twenty-one farms purchased 19 tons of skimmilk to feed to heifers. The average price paid was 17 cents per hundred pounds. All skimmilk averaged 232 pounds per heifer calf on hand at the end of the year.

Grain.— The average amount of grain used was 531 pounds per cattle unit of heifers, or 267 pounds per head. The amount of calf meal used per heifer under one year old on hand at the end of the year was 25 pounds.

Succulent feed.— Forty-five farms fed silage to heifers. The total amount fed, divided by the number of heifers on all farms, averaged 1234 pounds per cattle unit, or 619 pounds per head. The average for farms feeding silage was 3160 pounds per cattle unit, or 1580 pounds per head.

Small quantities of other succulent feeds were used on eleven farms.

Dry forage.— An average of 3207 pounds of dry forage per cattle unit, or 1609 pounds per head, was given to heifers.

Pasture.— In all, 122 farms pastured heifers at home. The average time pastured was 146 days per farm pasturing.

Labor

Most of the time spent in taking care of heifers is in winter. The average human hours were 55.1 per cattle unit, or 27.7 hours per head. The

cattle-unit figure represents about 71 per cent of the time spent per cow exclusive of milking. Of the labor on heifers, 45.8 hours were spent in winter and 9.3 hours in summer.

There is some horse labor in hauling feed and bedding, taking heifers to pasture, and buying and selling. This averaged 2.5 hours per cattle unit, or 1.3 hours per head.

Costs, returns, and profits

The gross cost per cattle unit of heifers was $56.84 (table 119). This checks with $56.63, the average value at time of freshening for heifers that calved for the first time, and illustrates how accurately farmers can estimate costs. The value of manure at $1.25 a ton amounted to $9.62 per cattle unit, and the appreciation on heifers $43.54 per cattle unit. These returns lacked $3.68 per cattle unit, or $1.85 for each heifer kept, of equaling the charges. Feed represents a larger proportion of the cost of raising a heifer than of the cost of keeping a milch cow.

TABLE 119. Average Costs and Returns for 1002 Heifers

	Total	Per cattle unit	Per head	Per cent
Costs:				
Whole milk	$3,517.77	$ 7.00	$3.51	12.3
Skimmilk:				
Farm	171.17	0.34	0.17	0.6
Purchased	64.00	0.13	0.07	0.2
Buttermilk	2.45	0.01	0.00	.....
Grain	4,390.00	8.73	4.38	15.4
Silage	1,548.00	3.08	1.55	5.4
Other succulent feed	152.00	0.30	0.15	0.5
Dry forage	8,146.00	16.20	8.13	28.5
Pasture	1,907.00	3.79	1.90	6.7
Bedding	292.00	0.58	0.29	1.0
Human labor	4,160.10	8.28	4.15	14.6
Horse labor	188.85	0.38	0.19	0.7
Use of buildings	2,143.21	4.26	2.14	7.5
Use of equipment	221.45	0.44	0.22	0.8
Interest on stock	1,181.30	2.35	1.18	4.1
Interest on feed and supplies	305.50	0.61	0.31	1.1
Miscellaneous	182.00	0.36	0.18	0.6
Total costs	$28,572.80	$56.84	$28.52	100.0
Returns:				
Manure	$ 4,837.65	$ 9.62	$ 4.83	18.1
Appreciation	21,887.00	43.54	21.84	81.9
Total returns	$26,724.65	$53.16	$26.67	100.0
Difference (= loss)	$1,848.15	$3.68	$1.85	.....
Value at birth, plus purchases, less sales and hides	$2,434.00	$4.84	......	.....
Cost of raising a heifer to two years old	$26,169.15	$52.06	......	.....

The cost of raising a heifer to two years old is the total cost, \$56.84, plus the value at birth, \$4.44 per cattle unit, plus heifer purchases, \$3.64, less heifer sales and hides, \$3.24, less manure, \$9.62 per cattle unit—a net cost of \$52.06 per head. Since some heifers die or are disposed of before freshening, the cost per head of those that freshen is higher.

Size of herd

The number of heifers kept is not always proportional to the number of cows, but the methods of feeding and taking care of heifers is perhaps influenced more by the number of cows than by the number of heifers kept.

Like cows, heifers are fed more intensively in the larger herds. More milk, more grain, more silage, and more dry forage was used by heifers on farms keeping more than eighteen cows than on farms keeping from six to ten cows. Heifers also had a higher valuation in the larger herds than in the smaller herds, a safe indication that they were better grown. It is probable that they make a better class of cows, because they come from better stock and are better grown than the heifers in small herds.

The relation of the number of heifers raised to the labor cost of raising them is shown in table 120:

TABLE 120. RELATION OF NUMBER OF HEIFERS RAISED TO LABOR COST OF RAISING

Number of heifers per farm	Number of farms	Cattle units of heifers per farm	Hours per cattle unit*	Cost of labor at various rates per hour				
				15 cents	20 cents	25 cents	30 cents	35 cents
4.7	53	2.3	69.2	\$10.38	\$13.84	\$17.30	\$20.76	\$24.22
11.5	28	5.8	47.7	7.16	9 54	11.92	14.31	16.70
Difference between groups	......	3.5	21.5	\$3.22	\$4.30	\$5.38	\$6.45	\$7.52

* Labor in raising a heifer to two years of age.

Heifers in three seasonal groups

The intensity of the methods used in feeding and taking care of heifers is closely correlated with the intensity of the methods used in handling the milking herd. That is, in summer dairies heifers receive less feed, particularly silage, than in winter dairies. But the amount of labor required is much the same, regardless of the proportion of milk produced in summer.

In the summer dairies, wheat by-products, ground oats and corn, and oats, made up 60 per cent of the concentrates fed heifers. In winter dairies these made up only 33 per cent of the concentrates, chiefly because more mixed feed, cornmeal, and gluten were used in these herds. The data are given in table 121:

TABLE 121. RELATION OF SEASON OF PRODUCTION TO CONCENTRATES USED BY HEIFERS

Kind of feed	Less than 33 per cent of milk sold during May, June, and July. Winter dairies, 54 farms, 210.3 heifer cattle units		More than 40 per cent of milk sold during May, June, and July. Summer dairies, 41 farms, 128.7 heifer cattle units	
	Pounds	Per cent	Pounds	Per cent
Cornmeal	13,480	11.0	5,405	9.4
Gluten	14,210	11.6	4,375	7.6
Hominy	500	0.4	3,075	5.4
Corn and oats	300	0.2	6,350	11.1
Whole oats	....	.....	700	1.2
Ground oats	*5,264	4.3	5,790	10.1
Wheat bran	13,070	10.7	2,275	4.0
Wheat feed	19,445	15.8	16,220	28.3
Wheat middlings	1,940	1.6	3,775	6.6
Cottonseed meal	2,405	2.0	300	0.5
Oilmeal	2,820	2.3	1,450	2.5
Calf meal	6,752	5.5	3,410	6.0
Brewers' grains	590	0.5	210	0.4
Dried beet pulp	....	.....	100	0.2
Other grains not by-products	2,370	1.9	310	0.5
Mixed feeds	39,465	32.2	3,560	6.2
Total†	122,611	100.0	57,305	100.0

* Including a small quantity of whole oats not recorded separately.
† Omitting salt.

In summer dairies a larger proportion of the roughage fed heifers was corn stover and oat straw than in winter dairies. The figures showing the roughages used are given in table 122:

TABLE 122. RELATION OF SEASON OF PRODUCTION TO ROUGHAGES USED BY HEIFERS

Kind of feed	Less than 33 per cent of milk sold during May, June, and July. Winter dairies, 54 farms, 210.3 heifer cattle units		More than 40 per cent of milk sold during May, June, and July. Summer dairies, 41 farms, 128.7 heifer cattle units	
	Tons	Per cent	Tons	Per cent
Succulent feeds:				
Corn silage	183.6	98.3	25.0	69.4
Green corn	2.5	1.3	1.0	2.8
Turnips	....	......	10.0	27.8
Mangels	0.5	0.3	....	.....
Potatoes	0.2	0.1	....	.....
Total	186.8	100.0	36.0	100.0

TABLE 122 *(concluded)*

Kind of feed	Less than 33 per cent of milk sold during May, June, and July. Winter dairies, 54 farms, 210.3 heifer cattle units		More than 40 per cent of milk sold during May, June, and July. Summer dairies, 41 farms, 128.7 heifer cattle units	
	Tons	Per cent	Tons	Per cent
Dry forage:				
Alfalfa hay	3.0	0.8	....	.....
Clover hay	12.0	3.2	....	.....
Clover (second cut)	1.5	0.4	2.0	1.0
Timothy hay	50.8	13.6	8.8	4.4
Mixed hay	277.6	74.2	158.2	79.5
Oat hay	2.5	0.7	5.0	2.5
Oat and pea hay	3.1	0.8	1.5	0.8
Millet	8.2	2.2	3.0	1.5
Oat straw fed	0.9	0.2	5.5	2.8
Corn stover	14.6	3.9	14.9	7.5
Total	374.2	100.0	198.9	100.0

Further data on the relation of season of milk production to various factors for heifers are given in table 123.

Practically every item of cost for heifers and every item of return is less in summer dairies than in herds following the winter system. The cost of raising a heifer to two years old in the winter dairies was $57.83 and in the summer dairies was $44.75. There was little difference, however, in the value at freshening. Probably those in winter herds freshened at an earlier age, so that the relative difference between cost up to the time of freshening and value may not be as much as the figures suggest.

Data showing the relation of production and season of production to costs and returns for heifers are given in tables 124 and 125.

The fact that the ratio of heifer calves to older heifers was higher in summer dairies suggested the possibility of a change in the relative cost of raising a heifer in the different season groups, if the younger heifers were considered the equivalent of one-fourth cattle unit each, and the older heifers one-half cattle unit each, instead of all as one-half cattle unit. But the relative costs per cattle unit are not changed noticeably by this method of calculation.

More heifers in proportion to cows were found in the small herds and in the summer dairies.

Production per cow, and costs and returns for heifers

No tabulation was made to show the detailed costs and returns for heifers in low- and high-producing herds, because production per cow is closely correlated with season of production.

TABLE 123. RELATION OF SEASON OF MILK PRODUCTION TO AMOUNTS OF FEED USED, LABOR REQUIRED, AND OTHER QUANTITIES, FOR HEIFERS

	Less than 33 per cent of milk sold during May, June, and July			From 33 to 40 per cent of milk sold during May, June, and July.			More than 40 per cent of milk sold during May, June, and July		
	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head
Number of farms	54	.....	.....	51	.....	.....	41	.....	.....
Average number of heifers	420.5	.....	.....	325.0	.....	.....	256.5	.....	.....
Average cattle units of heifers	210.3	.....	.....	163.7	.....	.....	128.7	.....	.....
Pounds of whole milk	92,009	438	219	81,603	498	251	41,852	325	163
Pounds of skimmilk:									
Separated on farm	31,450	150	75	36,120	221	111	28,498	221	111
Purchased	11,910	57	28	16,015	98	49	9,450	73	37
Pounds of buttermilk	1,000	5	2	....	.....	.....	300	2	1
Pounds of grain	123,808	589	294	86,003	525	265	57,305	445	223
Silage	183.6 tons	1,746 pounds	873 pounds	101.5 tons	1,240 pounks	625 pounds	25.0 tons	389 pounds	195 pounds
Other succulent feed	3.25 tons	31 pounds	15 pounds	11.0 tons	134 pounds	68 pounds	11.0 tons	171 pounds	86 pounds
Dry forage	374.15 tons	3,558 pounds	1,779 pounds	233.05 tons	2,847 pounds	1,434 pounds	198.95 tons	3,092 pounds	1,551 pounds
Days on pasture	7,016	*156	.....	5,564	*129	.....	5,238	*154	.....
Hours of human labor:									
Summer	1,364	6.5	3.2	1,692	10.3	5.2	1,640	12.7	6.4
Winter	9,664	46.0	23.0	7,940	48.5	24.4	5,434	42.2	21.2
Hours of horse labor	636	3.0	1.5	375	2.3	1.2	248	1.9	1.0
Average value of heifers	$10,943	$52.04	$26.02	$7,351	$44.91	$22.62	$5,332	$41.43	$20.79
Heifers that became cows	158	.....	.....	88	.....	.....	58	.....	.....
Average value at time of freshening	....	.....	$57.35	....	.....	$54.06	....	.....	$58.62

* Per farm pasturing.

TABLE 124. RELATION OF SEASON OF PRODUCTION TO COSTS AND RETURNS FOR HEIFERS

	Less than 33 per cent of milk sold during May, June, and July			From 33 to 40 per cent of milk sold during May, June, and July			More than 40 per cent of milk sold during May, June, and July		
	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head
Costs:									
Grain	$2,016.00	$ 9.59	$ 4.79	$1,409.00	$ 8.61	$ 4.33	$ 965.00	$ 7.50	$3.76
Silage	917.00	4.36	2.18	506.00	3.09	1.56	125.00	0.97	0.49
Other succulent feed	9.00	0.04	0.02	78.00	0.48	0.24	65.00	0.51	0.25
Dry forage	3,900.00	18.54	9.27	2,383.00	14.56	7.33	1,863.00	14.48	7.26
Whole milk	1,561.61	7.43	3.72	1,306.89	7.98	4.02	649.27	5.04	2.53
Skimmilk:									
Separated on farm	49.03	0.23	0.12	67.37	0.41	0.21	54.77	0.43	0.21
Purchased	20.00	0.10	0.05	27.00	0.16	0.08	17.00	0.13	0.07
Buttermilk	1.70	0.01	....	....	....	....	0.75	0.01	....
Pasture	936.00	4.45	2.23	538.00	3.29	1.66	433.00	3.36	1.69
Bedding	121.00	0.58	0.29	116.00	0.71	0.36	55.00	0.43	0.21
Human labor	1,654.20	7.87	3.93	1,444.80	8.82	4.45	1,061.10	8.24	4.14
Horse labor	95.40	0.45	0.23	56.25	0.34	0.17	37.20	0.29	0.15
Use of buildings	1,041.36	4.95	2.48	659.89	4.03	2.03	441.96	3.43	1.72
Use of equipment	92.50	0.44	0.22	81.10	0.50	0.25	47.85	0.37	0.19
Interest on stock	547.15	2.60	1.30	367.55	2.25	1.13	266.60	2.07	1.04
Interest on feed and supplies	144.00	0.68	0.34	99.00	0.60	0.30	62.50	0.49	0.24
Miscellaneous	76.00	0.36	0.18	85.00	0.52	0.26	21.00	0.16	0.08
Total costs	$13,181.95	$62.68	$31.35	$9,224.85	$56.35	$28.38	$6,166.00	$47.91	$24.03
Returns:									
Manure	$2,115.25	$10.06	$ 5.03	$1,577.30	$ 9.64	$ 4.85	$1,145.10	$ 8.90	$4.46
Appreciation	9,492.00	45.13	22.57	7,231.00	44.17	22.25	5,164.00	40.12	20.14
Total returns	$11,607.25	$55.19	$27.60	$8,808.30	$53.81	$27.10	$6,309.10	$49.02	$24.60
Difference (= profit or loss)	—$1,574.70	—$7.49	—$3.75	—$416.55	—$2.54	—$1.28	+$143.10	+ $1.11	+$0.57
Value at birth, plus purchases, less sales and hides	$1,095.00	$5.21	....	$600.00	$3.67	....	$739.00	$5.74	....
Cost of raising a heifer to two years old	$12,161.70	$57.83	....	$8,247.55	$50.38	....	$5,759.90	$44.75	....

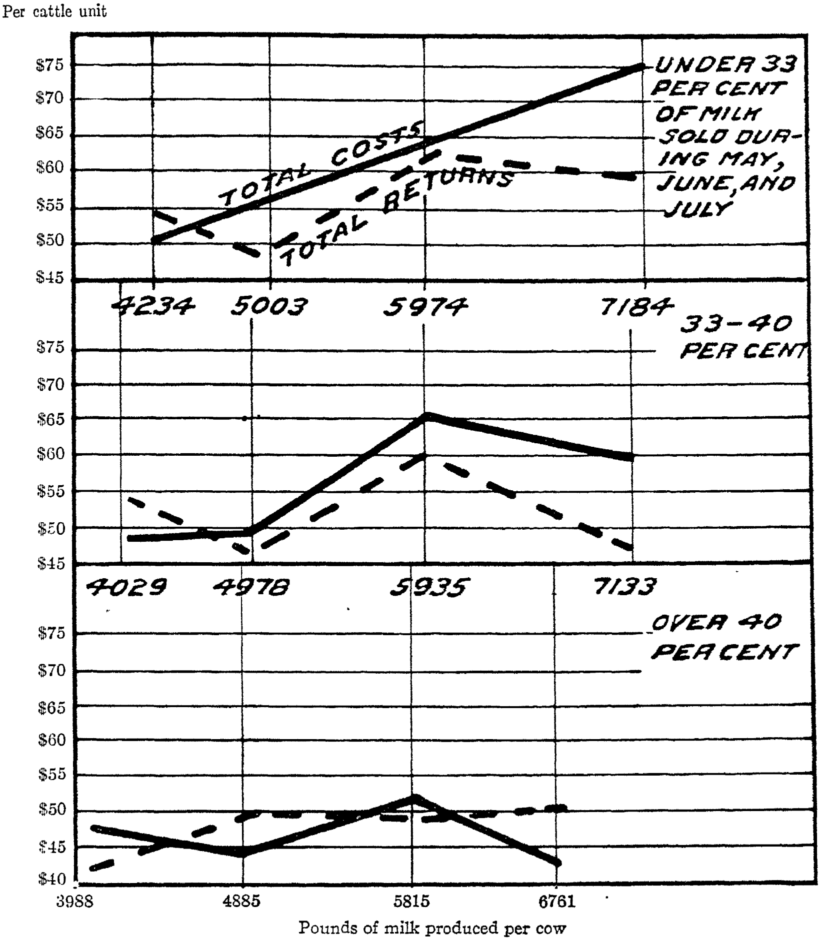


FIG. 69. RELATION OF PRODUCTION PER COW AND SEASON OF PRODUCTION TO COSTS AND RETURNS FOR HEIFERS

The difference in the cost of raising heifers in low-producing and in high-producing herds was greater in winter dairies than in summer dairies

Almost without exception the cost of raising heifers in high-producing herds is greater than in low-producing herds. The difference is greater in winter dairies than in summer dairies. The least cost per heifer was in the lower-producing summer dairies, and the highest cost per heifer was in the higher-producing winter dairies.

Probable cost at 1920 prices

Feed, labor, and other costs advanced from 1915 to 1920, and therefore the cost of raising a cow in 1920 was much higher than in 1915. An attempt has been made to estimate the probable cost in 1920 by applying approxi-

mate prices for that year to the quantities found in this investigation. In table 126 this cost is given for winter dairies, and in table 127 for summer dairies.

TABLE 125. RELATION OF PRODUCTION AND SEASON OF PRODUCTION PER COW TO COSTS AND RETURNS FOR HEIFERS

Per cent of milk sold during May, June, and July	Pounds of milk produced per cow			
	Under 4500	4501–5500	5501–6500	Over 6500
Less than 33 per cent:				
Cost per cattle unit	$50	$56	$64	$76
Returns per cattle unit	54	48	62	60
Gain or loss	+ 4	— 8	— 2	— 16
From 33 to 40 per cent:				
Cost per cattle unit	$49	$49	$66	$61
Returns per cattle unit	54	47	61	49
Gain or loss	+ 5	— 2	— 5	— 12
More than 40 per cent:				
Cost per cattle unit	$47	$45	$53	*$43
Returns per cattle unit	42	50	51	52
Gain or loss	— 5	+ 5	— 2	+ 9
Average:				
Cost per cattle unit	$49	$51	$61	$71
Returns per cattle unit	51	48	58	58
Gain or loss	+ 2	— 3	— 3	— 13
Value of heifers that became cows	52	56	58	59

* Only two farms in this group.

TABLE 126. PROBABLE 1920 COST OF RAISING A HEIFER TO TWO YEARS OF AGE IN WINTER DAIRIES, BROOME COUNTY

(Less than 33 per cent of milk sold in May, June, and July, 54 farms, 208 heifers under one year, 212 heifers one year old or over, 210.3 cattle units of heifers)

	Average per cattle unit	Price in 1914–15	Actual cost per cattle unit in 1914–15	Estimated 1920 price	Estimated cost per cattle unit at 1920 prices
Whole milk	438 pounds	$ 1.70	$ 7.43	$ 3.57	$15.64
Skimmilk	212 pounds	0.16	0.34	0.80	1.70
Grain	589 pounds	32.66	9.59	60.00	17.67
Silage	1,746 pounds	5.00	4.36	7.00	6.11
Other succulent feed	31 pounds	2.58	0.04	5.00	0.08
Hay	3,411 pounds	10.54	17.97	20.00	34.11
Other dry forage	147 pounds	7.76	0.57	10.00	0.74
Human labor	52.5 hours	0.15	7.87	0.35	18.38
Feed and labor	....	......	$48.17	......	$94.43
Per cent of total cost	....	......	83.3	......	....
Total cost for two years	....	......	$57.83*	......	$113.36
Value of heifers that became cows	....	......	$57.34	......	....

* The total cost of keeping a heifer for two years equals the value at birth of heifers born during the year, plus the cost of heifers purchased, plus other heifer costs, less receipts for heifers and heifer hides sold, less value of manure, divided by the number of cattle units of heifers.

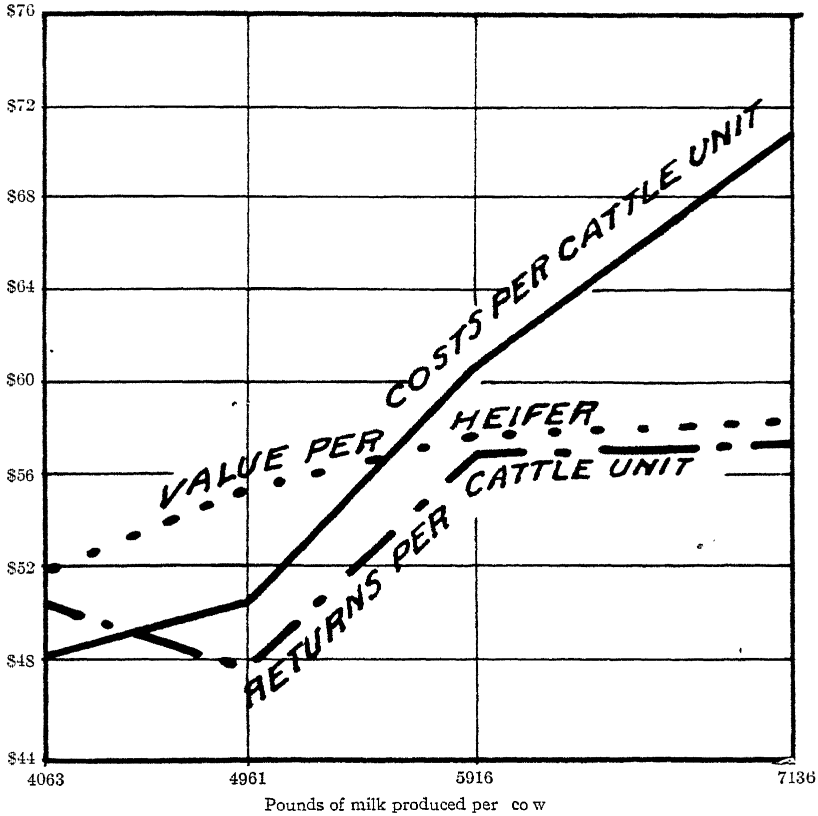


FIG. 70. RELATION OF PRODUCTION PER COW TO COSTS AND RETURNS PER CATTLE UNIT OF HEIFERS

TABLE 127. PROBABLE 1920 COST OF RAISING A HEIFER TO TWO YEARS OF AGE IN SUMMER DAIRIES, BROOME COUNTY

(More than 40 per cent of milk sold in May, June, and July, 41 farms, 144 heifers under one year, 113 heifers one year old or over, 128.7 cattle units of heifers)

	Average per cattle unit	Price in 1914–15	Actual cost per cattle unit in 1914–15	Estimated 1920 price	Estimated cost per cattle unit at 1920 prices
Whole milk	325 pounds	$ 1.55	$ 5.04	$ 3.25	$10.56
Skimmilk	296 pounds	0.19	0.57	0.80	2.37
Grain	445 pounds	33.71	7.50	60.00	13.35
Silage	389 pounds	5.00	0.97	7.00	1.36
Other succulent feed	171 pounds	2.98	0.51	5.00	0.43
Hay	2,776 pounds	9.94	13.80	20.00	27.76
Other dry forage	316 pounds	4.30	0.68	10.00	1.58
Human labor	54 9 hours	0.15	8.24	0 35	19.22
Feed and labor	....	......	$37.31	......	$76.63
Per cent of total cost	....	......	83.4	......	....
Total cost for two years	....	......	$44 75	......	$91.88
Value of heifers that became cows	....	......	$58.62	......	....

Results for first and second years from other sources

The quantities of feed used in raising a limited number of heifers the first and second years have been reported. These are given in table 128. If estimated 1920 prices in New York are applied to these quantities, as previously to the Broome County quantities, the results are as given in table 129.

One cannot absolutely precalculate costs, first, because of the uncertainty of choosing correct prices to apply to quantities, and secondly, because of the fact that changes in prices cause changes in practice.

TABLE 128. QUANTITIES OF FEED USED IN RAISING HEIFERS, FIRST AND SECOND YEARS. VARIOUS INVESTIGATIONS

	Wisconsin farm [1]	Ohio experiment station [2]	Ohio experiment station [3]	12 Ohio farms [4]	Connecticut experiment station [5]	Average
	Jersey	Jersey	Holstein		Holstein, Jersey, Guernsey	
First year:						
Number of heifers	20	40	29	......	5	....
Whole milk (pounds)	342	465	499	510	445	452
Skimmilk (pounds)	3,165	2,928	2,786	1,860	2,953	2,738
Grain (pounds)	547	597	656	378	303	496
Silage (pounds)	353	458	586	851	1,244	698
Hay (pounds)	857	709	768	806	918	812
Corn stover (pounds)	......	40	29	348	....	83
Pasture (days)	123	122	128	122	?	?
Second year:						
Number of heifers	17	29	22	......	5	....
Skimmilk (pounds)	......	87	174	72	....	67
Grain (pounds)	......	785	870	279	434	474
Silage (pounds)	3,250	2,426	2,247	3,422	1,693	2,608
Hay (pounds)	1,120	1,038	1,419	1,308	2,227	1,422
Corn stover (pounds)	672	254	232	652	....	362
Pasture (days)	171	159	151	176	168	165
Weight at birth (pounds)	......	56	82	......	....	....
Weight at one year (pounds)	......	472	571	......	....	....
Weight at two years (pounds)	......	758	962	......	....	....

[1] United States Agricultural Department, Bul. 49, pages 6 and 10.
[2] Ohio Agricultural Experiment Station. Bul. 289, pages 9–10.
[3] Ohio Agricultural Experiment Station. Bul. 289, pages 13–14.
[4] Ohio Agricultural Experiment Station, Monthly Bul., vol. 2, no. 9, page 292.
[5] Storrs Agricultural Experiment Station, Bul. 63.

TABLE 129. PROBABLE 1920 COST FOR FIRST AND SECOND YEARS. VARIOUS INVESTIGATIONS

	Average per heifer (pounds)	Estimated 1920 price	Cost at estimated 1920 prices
First year:			
Whole milk	452	$ 3.57	$16.14
Skimmilk	2,738	0.80	21.90
Grain	496	60.00	14.88
Silage	698	7.00	2.44
Hay	812	20.00	8.12
Corn stover	83	10.00	0.42
Barn feed first year	....	....	$63.90

TABLE 129 (*concluded*)

	Average per heifer (pounds)	Estimated 1920 price	Cost at estimated 1920 prices
Second year:			
Skimmilk	67	$ 0.80	$ 0.54
Grain	474	60.00	14.22
Silage	2,608	7.00	9.13
Hay	1,422	20.00	14.22
Corn stover	362	10.00	1.81
Barn feed second year			$39.92
Total for two years			$103.82
Labor (Broome County winter dairies), 52.5 hours at 35 cents			$18.38
Assuming feed and labor at 83.3 per cent (Broome County winter dairies), total cost for two years			$146.70

PART IV. CONCERNING HERD BULLS

On 17 farms no herd bulls were owned. Of these 17, 4 pastured bulls in return for their use, 7 hired bull service, and 6 received the use of a bull free. The remaining 132 farms used their own bulls. On these farms the common practice was to raise a bull calf to be used for one or two years and then sold for slaughter. In some cases this was a purchased calf, but too often it was a grade calf from the farmer's own herd.

Bull calves to be kept

About 40 per cent of the farms reported calves on hand to be kept for herd bulls. The average number was 67, valued at $1074, or $16.03 a head. During the year 24 were purchased to be raised, for $752, an average price of $31.33 a head. On 50 farms, 54 of the bull calves born during the year were kept for future use. Their average value at birth was $4.19. Two were slaughtered or sold for slaughter at an average price of $20, and two died.

Herd bulls from one to two years old

The average number of bulls on hand from one to two years old was 60, valued at $2162, or $36.15 a head. During the year there were 20.5 bulls of this age purchased for $35.07 each, 25.5 slaughtered or sold for slaughter at $38.82 each, 7 sold to be used in other herds at $44 each, and one that died.

Herd bulls more than two years old

A lesser number of older herd bulls were kept. The average number more than two years old was 45, valued at $3102, or about $68.93 a head. During the year 10.5 bulls more than two years old were purchased at $43.62 each, 30 were slaughtered or sold for slaughter at $56.56 each, and 7 were sold to be used in other herds at an average price of $81.86 each.

Bulls of this age are commoner in the larger herds. Of all bulls more than one year old sold, less than one-fourth went for service in other herds.

On the 132 farms there was an average number of 171.7 herd bulls, representing 109.1 cattle units. In calculating the cattle units of herd bulls, those more than two years old were considered as one cattle unit and all under this age as one-half cattle unit.

Feed used

The amounts and kinds of feed used by bulls have been given in tables 1 to 3 (pages 280 to 284).

Whole milk.— On 65 farms, 26,275 pounds of whole milk were fed to 67 bull calves to be kept. This is an average of 392 pounds per calf. From 200 to 600 pounds was the usual amount fed, depending largely on the price of milk at the time the calf was started, the amount of skimmilk available, whether or not the calf was purebred, and other factors. When feeding was heavier, rarely did the increased value of the calf equal the value of the milk used. In one grade herd, a purebred Holstein calf valued at $20 at birth was fed whole milk for twelve weeks — a total of 1820 pounds, which would have sold for $33.31, being used. This calf used also 100 pounds of calf meal, costing $3, and a small quantity of hay. At the end of the period he was valued at $50. Seldom does it pay to feed as much milk as this to a bull calf. Bull calves started largely on milk substitutes develop bone and frame, and, if fed equally well later, usually make as satisfactory animals as do calves fed heavily on whole milk, and at much less cost.

Skimmilk.— Eight farms had their own skimmilk, and five purchased skimmilk to feed to bulls to be kept. The average amount fed was about 636 pounds per calf using it, but the amount varied from 200 to nearly 2000 pounds. In some instances skimmilk was substituted for all of the whole milk except a few feeds. Where plenty of skimmilk is available at a reasonable price, the feeding of whole milk after the first week to bulls to be raised is too expensive.

Grain.— Of 132 farms keeping herd bulls, 108 fed the bulls grain. The average amount used was 533 pounds per cattle unit, or 339 pounds per head. Ten farms fed 1000 pounds or more per bull. It is questionable whether for bulls of this quality as much grain as 1000 pounds is good economy except in finishing a bull for the block.

On 21 farms, 1426 pounds of calf meal was fed to bulls to be kept. This is about 68 pounds per calf using meal.

Succulent feed.— On 39 farms, 78 tons of silage was fed to herd bulls. The amount varied from 0.5 ton to 4 tons per farm. The average quantity used was 1430 pounds per cattle unit, or 909 pounds per head. In no case was more than 4 tons given to a bull.

On 6 farms, small quantities of turnips, potatoes, and mangels were used. The average was 52 pounds per cattle unit, or 33 pounds per head.

Dry forage.— The larger proportion of the feed given to bulls is mixed hay and other dry forage. This varied from 0.1 ton to 5 tons per farm. The usual allowance was from 1 to 3 tons for a yearling or an older bull. If the roughage is of good quality, a bull will keep in good condition on little else. The average amount fed was 3430 pounds per cattle unit, or 2179 pounds per head.

Pasture.— On 100 farms, bulls were allowed to pasture with the cows an average of 131 days per farm. On the remaining 32 farms they were kept in the stable and the barnyard thruout the year, or tethered a part of the time on the meadows. The practice of pasturing is commoner in the summer dairies.

Often when it was not desired or was not possible to pasture the bull with the herd, practically full feed from shortly after the hay was cut till late in the fall was provided by staking him on a near-by meadow. This saved the expense for hay and the time spent in taking care of the bull in the stable, but necessitated the spending of extra time in providing water.

Usually the cheapest way of summering a bull is to allow him to pasture with the herd; the next cheapest is tethering him; and the most expensive is keeping him in the stable. A bull will make better gains in the field than in the barn during summer, and this is particularly important if he is about to be sold.

Labor

Since on most farms the bulls were pastured practically four-fifths of the pasture season, the labor required during the summer was negligible.

TABLE 130. AVERAGE AMOUNT OF FEED USED, LABOR REQUIRED, AND OTHER QUANTITIES, FOR 67 BULL CALVES TO BE KEPT, 59.7 HERD BULLS FROM ONE TO TWO YEARS OLD, AND 45 HERD BULLS MORE THAN TWO YEARS OLD

	Total*	Per cattle unit	Per head	Number of farms using
Number of farms	132	......	......	......
Average number of herd bulls	171.7	......	......	......
Average cattle units of herd bulls	109.1	......	......	......
Pounds of whole milk	26,275	241	153	65
Pounds of skimmilk:				
Separated on farm	6,493 }	85	54	{ 8
Purchased	2,775 }			{ 5
Pounds of grain	58,203	533	339	108
Silage	78 tons	1,430 pounds	909	39
Other succulent feed	2.85 tons	52 pounds	33	6
Dry forage	187.1 tons	3,430 pounds	2,179	118
Days on pasture	13,139	†131	......	100
Hours of human labor:				
Summer	1,145	10	7	35
Winter	6,852	63	40	120
Hours of horse labor	37	0.3	0.2	5
Average value of herd bulls	$6,335	$58.07	$36.90	......

*Given in previous tables.
†Per farm pasturing.

The time spent in summer averaged 10 hours per cattle unit, or about 7 hours per head, while that spent in winter averaged 63 hours per cattle unit, or 40 hours per head (table 130). The maximum time spent on herd bulls, on any farm, was 227 hours. The average total time was 73 hours per cattle unit, or a little more than a third of the time spent in taking care of a cow and handling her product.

All the returns from herd bulls averaged $41.65 per cattle unit, or $26.47 per head (table 131). On 35 of the 132 farms, the returns exceeded the cost of herd bulls.

TABLE 131. AVERAGE COSTS AND RETURNS FOR 67 BULL CALVES TO BE KEPT, 59.7 HERD BULLS FROM ONE TO TWO YEARS OLD, AND 45 HERD BULLS MORE THAN TWO YEARS OLD

	Total	Per cattle unit	Per head	Per cent
Number of bulls	171.7	......	......	....
Number of cattle units	109.1	......	......	....
Costs:				
Whole milk	$ 429.47	$ 3.94	$ 2.50	6.8
Skimmilk	17.08	0.16	0.10	0.3
Grain	948.00	8.69	5.52	15.0
Silage	388.00	3.56	2.26	6.1
Other succulent feed	9.00	0.08	0.05	0.2
Dry forage	1,911.00	17.52	11.13	30.2
Pasture	346.00	3.17	2.01	5.5
Total feed	$4,048.55	$37.12	$23.57	64.1
Bedding	115.00	1.05	0.67	1.8
Human labor	1,199.55	10.99	6.99	18.9
Horse labor	5.55	0.05	0.03	0.1
Use of buildings	464.46	4.26	2.71	7.3
Use of equipment	71.65	0.66	0.42	1.1
Interest on stock	316.75	2.90	1.84	5.0
Interest on feed and supplies	91.00	0.83	0.53	1.4
Miscellaneous	20.00	0.18	0.12	0.3
Total costs	$6,332.51	$58.04	$36.88	100.0
Returns:				
Manure	$1,063.21	$ 9.75	$ 6.19	23.4
Appreciation	3,339.00	30.60	19.45	73.5
Amount received for service	142.00	1.30	0.83	3.1
Total returns	$4,544.21	$41.65	$26.47	100.0
Difference (= cost of keeping herd bulls)	$1,788.30	$16.39	$10.41	....
Amount paid for service, 28 farms	$183.00	$1.68	$1.07	....
Total cost of bull service	$1,971.30	$18.07	$11.48	....

Cost of keeping herd bulls

The difference between the costs and returns was considered the cost of keeping herd bulls and was charged to cows. This averaged $16.39 per cattle unit, or $10.41 per head.

Cost of bull service on farms keeping herd bulls

In addition to the costs just given, \$125 was paid by 18 of the farms keeping herd bulls, for the use of other bulls. This makes the cost of bull service on farms keeping herd bulls \$1913.30, or 99 cents per cow.

Cost of bull service on farms hiring service only

On 7 other farms, keeping 65.5 cows, \$58 was paid for the use of bulls. The cost of bull service per cow for these farms was 82 cents, in addition to the time spent driving the cows.

Total cost of bull service

Thus, on 149 farms the cost of bull service was \$1971.30, or 96 cents per cow kept, including 6 farms that received the use of a bull free. The cost reached as high as \$5 per cow on some farms. On farms where the returns from herd bulls exceeded the cost, the excess was credited to cows.

Comparison of grade and purebred bulls

On 39 farms purebred bulls were kept. Of these, 30 used registered Holsteins, 6 used Holsteins eligible to registry, and 3 used registered Guernseys. On the remaining 93 farms, grade bulls were used.

Purebred bulls were fed more liberally and were given more care than were grades. Excepting pasture, horse labor, and skimmilk, every item of cost was higher for purebred bulls than for grades.

Comparative figures for grade and purebred bulls in relation to various factors are given in tables 132 to 136.

The fact that the costs are slightly less is no argument for using grade bulls. There are many farmers now using grade bulls who should have a purebred bull of one of the leading dairy breeds. The larger the herd and the more intensive the system, the more important this becomes. The damage resulting from the use of a poor bull is much greater in a large herd than in a small one.

Age of bull

The increased value of bull calves and of yearling bulls is more likely to exceed the cost of their keep than is the increased value of older bulls. Ordinarily, therefore, the practice of selling bulls after one or two years of use results in cheaper bull service or greater net returns from herd bulls than where they are kept longer. Under unusual conditions with purebred or high-grade animals this may not be true.

Of the 132 farms with herd bulls, there were 16 that kept grade bulls and 12 that kept purebred bulls, all one year old or older. There were also 56 other farms that kept grade bulls and 12 other farms that kept purebred bulls, all of which were less than two years old. The costs and returns for herd bulls on these farms illustrate the point made in the pre-

TABLE 132. FEED USED, LABOR REQUIRED, AND OTHER QUANTITIES FOR HERD BULLS

Items	Grades			Purebreds		
	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head
Number of farms	93	....	....	39	....	....
Number of cows	1,240.5	....	....	647.5	....	....
Number of bulls	124.7	....	....	47.0	....	....
Cattle units of bulls	74.1	....	....	35.0	....	....
Value of bulls	$3,180	$42.91	$25.50	$3,155	$90.14	$67.13
Pounds of whole milk	18,083	244	145	8,192	234	174
Pounds of skimmilk	8,500	115	68	768	22	16
Pounds of grain	35,955	485	288	22,248	636	473
Succulent feed	39.6 tons	1,069 pounds	635 pounds	41.25 tons	2,357 pounds	1,755 pounds
Dry forage	123.1 tons	3,323 pounds	1,974 pounds	64.0 tons	3,657 pounds	2,723 pounds
Human hours	5,344	72	43	2,653	76	56
Horse hours	37	0.5	0.3	....	....	....

ceding paragraph. On many farms, bulls of all these ages were kept. In such cases the cost of keeping the older bulls was combined with the cost of raising the younger animals, and therefore these records are omitted from the tabulation.

TABLE 133. COSTS AND RETURNS FOR HERD BULLS

Items	Grades			Purebreds		
	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head
Costs:						
Whole milk	$ 292.37	$ 3.95	$2.34	$137.10	$ 3.92	$ 2.92
Skimmilk	15.41	0.21	0.12	1.67	0.05	0.03
Grain	595.00	8.03	4 77	353.00	10.09	7.51
Succulent feed	196.00	2.65	1.57	201.00	5.74	4.28
Dry forage	1,246.00	16.82	9.99	665.00	19.00	14.15
Pasture	265.00	3.58	2.13	81.00	2.31	1.72
Bedding	67.00	0.90	0.54	48.00	1.37	1.02
Human labor	801.60	10.81	6 43	397.95	11.37	8.47
Horse labor	4.80	0.06	0.04	0.75	0.02	0.02
Use of buildings	290.47	3.92	2.33	173.99	4.97	3.70
Use of equipment	45.35	0.61	0.36	26.30	0.75	0.56
Interest on stock	159.00	2.15	1.28	157.75	4.51	3.36
Interest on feed and supplies	55.50	0.75	0.45	35.50	1.01	0.75
Miscellaneous	4.00	0.05	0.03	16.00	0.46	0 34
Total costs	$4,037.50	$54.49	$32 38	$2,295.01	$65.57	$48 83
Returns:						
Manure	$ 693.18	$ 9.35	$ 5.56	$370.03	$10.57	$ 7.88
Appreciation	2,403.00	32.43	19.27	936.00	26.74	19.91
Amount received for service	34.00	0.46	0.27	108.00	3.09	2.30
Total returns	$3,130.18	$42.24	$25.10	$1,414.03	$40.40	$30.09
Difference (= cost of keeping herd bulls)	$907.32	$12.25	$7.28	$880.98	$25.17	$18.74
Amount paid for service	$153.00	$2.06	$1.23	$30.00	......	....
Total cost of bull service	$1,060.32	$14.31	$8.50	$910.98	......	....
Cost of service per cow	$0.85	......	......	$1.41	......	....

The costs for older bulls, either grades or purebreds, are higher than for younger bulls. In addition the increased value is less. The net cost of keeping the older bulls, therefore, is very much greater, either per cattle unit or per head. This makes the cost of bull service higher. Generally speaking, the herds are too small, the system of dairying is too extensive, the value of the offspring and the price for the milk are too low, and the winter feed for old bulls is too expensive, to justify keeping a bull beyond the second year of service if it is a grade or a scrub. Naturally there may be exceptions when bulls are owned jointly in purebred herds or when other conditions may be unusual for the region.

One of the important ways of keeping down the charge for the use of a bull is to have a large herd. By having a large herd the services of a much better bull may be obtained at no greater cost per cow than would be occasioned by the use of a poorer bull in a small herd. This is important when a valuable purebred bull is required.

The proportion of larger herds using older bulls is higher than that of small ones. As in the case of heifers, this has some influence on relative costs for the different groups.

TABLE 134. FEED USED, LABOR REQUIRED, AND OTHER QUANTITIES FOR HERD BULLS ON FARMS KEEPING ONLY BULLS ONE YEAR OLD OR OLDER

	Grades			Purebreds		
	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head
Number of farms	16	......	....	12	......	......
Number of cows	233.5	....	....	238.5	....	......
Number of bulls	12.5	....	....	11.0	....	....
Cattle units of bulls	10.1	....	....	10.5	......	....
Value of bulls	$509	$50.40	$40.72	$1,229	$117.05	$111 72
Pounds of grain	7,670	759	614	5,110	487	465
Succulent feed	11.35 tons	2,248 pounds	1,816 pounds	18.45 tons	3,514 pounds	3,355 pounds
Dry forage	20.10 tons	3,980 pounds	3,216 pounds	21.8 tons	4,152 pounds	3,964 pounds
Human labor (hours)	926	91.7	74.1	812	77 3	73 8
Days pastured	1,769	*161	....	1,547	*155	....

*Per farm pasturing.

TABLE 135. COSTS AND RETURNS FOR HERD BULLS ON FARMS KEEPING ONLY BULLS ONE YEAR OLD OR OLDER

	Grades			Purebreds		
	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head
Costs:						
Grain	$113.00	$11.19	$9.04	$77.00	$7.33	$7.00
Succulent feed	56.00	5.54	4.48	88.00	8.38	8.00
Dry forage	221.00	21.88	17.68	215.00	20.48	19.55
Pasture	52.00	5.15	4.16	28.00	2.67	2.55
Bedding	13.00	1.28	1.04	14.00	1.34	1.27
Human labor	138.90	13.75	11.11	121.80	11.60	11.07
Horse labor	1.80	0.18	0.14	.	.....	......
Use of buildings	44.61	4.42	3.57	46.20	4.40	4.20
Use of equipment	8.35	0.83	0.67	8.30	0.79	0.75
Interest on stock	25.45	2.52	2.04	61.45	5.85	5.59
Interest on feed and supplies	11.00	1.09	0.88	10.00	0.95	0.91
Miscellaneous	.....	..	.....	4.00	0.38	0.36
Total costs	$685.11	$67.83	$54.81	$673.75	$64.17	$61.25
Returns:						
Manure	$98.00	$9.70	$7.84	$107.57	$10.25	$9.78
Appreciation	286.00	28.32	22.88	159.00	15.14	14.46
Amount received for service	16.00	1.58	1.28	80.00	7.62	7.27
Total returns	$400.00	$39.60	$32.00	$346.57	$33.01	$31.51
Difference (=cost of keeping herd bulls)	$285.11	$28.23	$22.81	$327.18	$31.16	$29.74
Breeding fees	$2.00	$0.20	$0.16	$20.00	$1.90	$1.82
Cost of bull service	$287.11	$28.43	$22.97	$347.18	$33.06	$31.56
Cost per cow	$1.23	.....	.....	$1.46	......	...

TABLE 136. COSTS AND RETURNS FOR HERD BULLS ON FARMS KEEPING ONLY BULLS LESS THAN TWO YEARS OLD

	Grades			Purebreds		
	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head
Number of farms	56	......	......	12	......	......
Number of cows	691.0	......	.....	154.0	......	.....
Average number of herd bulls	78.2	......	......	11.0	.....	.....
Average cattle units of herd bulls	41.6	......	......	6.8	.....	...
Value of bulls	$1,683	$40.46	$21.52	$475.00	$69.85	$43.18
Total costs	$2,296.04	$55.19	$29.36	$522.82	$76.89	$47.53
Appreciation	$1,508.00	$36.25	$19.28	$284.00	$41.76	$25.82
Total returns	$1,902.48	$45.73	$24.33	$369.06	$54.27	$33.55
Cost of keeping bulls	$393.56	$9.46	$5.03	$153.76	$22.61	$13.98
Amount paid for service	$81.00	......	......	$10.00	......	.....
Cost of bull service	$474.56	......	......	$163.76	......	....
Cost of service per cow	$0.69	......	......	$1.06	......	.....

More grain, silage, and dry forage, and less milk, are used by bulls in the larger herds. This is partly due to the fact that more of the bulls are older, and partly to more intensive feeding. Also, less labor is required in their care.

Cost of bulls in three seasonal groups

Not only the costs and returns from cows and from heifers, but also the costs and returns from herd bulls, are closely correlated with the intensity of dairy methods. Where an intensive system prevails, the tendency

TABLE 137. RELATION OF SEASON OF MILK PRODUCTION TO AMOUNTS OF FEED USED, LABOR REQUIRED, AND OTHER QUANTITIES FOR HERD BULLS

	Less than 33 per cent of milk sold during May, June, and July			From 33 to 40 per cent of milk sold during May, June, and July			More than 40 per cent of milk sold during May, June, and July		
	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head
Number of farms	48	.....	.....	44	.....	.....	40	.....	...
Average number of herd bulls	57 4	....	.....	59.3	.....	.....	55 0	.....	....
Average cattle units of herd bulls	36.8	...	.....	38.4	.....	.....	33.9	.....	.....
Pounds of whole milk	10,497	285	183	8,299	216	140	7,479	221	136
Pounds of skimmilk:									
Separated on farm	2,000	54	35	1,780	46	30	2,713	80	49
Purchased	705	19	12	320	8	5	1,750	52	32
Pounds of grain	26,495	720	462	17,588	458	297	14,120	417	257
Silage	44 tons	2,391 pounds	1,533 pounds	25.85 tons	1,346 pounds	872 pounds	8.15 tons	481 pounds	296 pounds
Other succulent feed	0.5 ton	27 pounds	17 pounds	2.05 tons	107 pounds	69 pounds	0.3 ton	18 pounds	11 pounds
Dry forage	74.75 tons	4,062 pounds	2,605 pounds	60.15 tons	3,133 pounds	2,029 pounds	52.2 tons	3,080 pounds	1,898 pounds
Days on pasture	4,062	*145	.....	4,887	*136	.....	4,190	*116	....
Hours of human labor:									
Summer	514	14.0	9.0	377	9.8	6.4	254	7.5	4.6
Winter	2,774	75.4	48.3	2,253	58.7	38.0	1,825	53.8	33.2
Average value of herd bulls	$2,398	$65	$42	$2,283	$59	$38	$1,654	$49	$30
Per cent of bulls more than two years old	29.4	.....	.....	27.3	.....	.....	21.8	.....	.....
Per cent of bulls from one to two years old	31.2	.....	.....	37.2	.....	.....	36.4	.....	.....
Per cent of bull calves	39 4	.....	.....	35.5	.....	.....	41.8	.....	.....

* Per farm pasturing.

TABLE 138. Relation of Season of Milk Production to Costs and Returns for Herd Bulls

	Less than 33 per cent of milk sold during May, June, and July			From 33 to 40 per cent of milk sold during May, June, and July			More than 40 per cent of milk sold during May, June, and July		
	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head	Total	Per cattle unit	Per head
Costs:									
Grain	$433.00	$11.77	$ 7.55	$286.00	$ 7.45	$ 4.82	$229.00	$ 6.76	$4.16
Silage	219.00	5.95	3.82	129.00	3.36	2.18	40.00	1.18	0.73
Other succulent feed	1.00	0.03	0.02	6.00	0.16	0.10	2.00	0.06	0.04
Dry forage	784.00	21.30	13.66	628.00	16.35	10.59	499.00	14.72	9.07
Whole milk	181.65	4.94	3.16	132.70	3.46	2.24	115.12	3.39	2.10
Skimmilk:									
Separated on farm	3.00	0.08	0.05	3.56	0.09	0.06	4.52	0.13	0.08
Purchased	2.00	0.05	0.03	1.00	0.03	0.02	3.00	0.09	0.05
Pasture	114.00	3.10	1.99	110.00	2.86	1.86	122.00	3.60	2.22
Bedding	51.00	1.39	0.89	37.00	0.96	0.62	27.00	0.79	0.49
Human labor	493.20	13.40	8.59	394.50	10.27	6.65	311.85	9.20	5.67
Horse labor	1.50	0.04	0.03	4.05	0.10	0.07	....	......	....
Use of buildings	186.83	5.08	3.25	159.40	4.15	2.69	118.23	3.49	2.15
Use of equipment	25.95	0.70	0.45	29.10	0.76	0.49	16.60	0.49	0.30
Interest on stock	119.90	3.26	2.09	114.15	2.97	1.92	82.70	2.44	1.50
Interest on feed and supplies	37.00	1.00	0.64	32.50	0.85	0.55	21.50	0.63	0.39
Miscellaneous	8.00	0.22	0.14	6.00	0.16	0.10	6.00	0.18	0.11
Total costs	$2,661.03	$72.31	$46.36	$2,072.96	$53.98	$34.96	$1,598.52	$47.15	$29.06
Returns:									
Manure	$ 392.73	$10.67	$ 6.84	$ 372.18	$ 9.69	$ 6.28	$ 298.30	$ 8.80	$ 5.42
Appreciation	1,209.00	32.86	21.06	1,157.00	30.13	19.51	973.00	28.70	17.69
Amount received for service	46.00	1.25	0.81	66.00	1.72	1.11	30.00	0.88	0.55
Total returns	$1,647.73	$44.78	$28.71	$1,595.18	$41.54	$26.90	$1,301.30	$38.38	$23.66
Difference (= cost of herd bulls kept)	$1,013.30	$27.53	$17.65	$477.78	$12.44	$8.06	$297.22	$8.77	$5.40
Amount paid for service	$89.00	$2.42	$1.55	$56.00	$1.46	$0.94	$38.00	$1.12	$0.69
Total cost of bull service	$1,102.30	$29.95	$19.20	$533.78	$13.90	$9.00	$335.22	$9.89	$6.09

is to keep higher-priced bulls, to feed them more liberally, to bed them better, and to spend more time in their care. All of this increases the cost of their keep.

When the records were sorted by the proportion of milk sold in May, June, and July, the costs and returns for herd bulls were also tabulated. The ratio of bull calves to older bulls is much the same, regardless of the proportion of milk produced in summer.

Less grain, less silage, less dry forage, and less whole milk, was fed to herd bulls when a larger proportion of the milk was produced in summer (table 137).

All of the important items of cost for herd bulls are less in the herds where summer dairying is largely practiced. Less manure is recovered, and the appreciation on bulls is also less, in those herds. But the difference between costs and returns, or the net cost of keeping bulls, is also less in summer dairies than in winter dairies. (Table 138.)

PART V. CONCERNING VEALS AND BULLS TO BE SOLD

The average number of veal calves inventoried was 16, valued at $9.25 a head, and of bull calves being raised to be sold 22, valued at $14.18 a head.

Only four calves were purchased to be fattened. Six bulls were bought to be sold later when partly raised. There were 937 calves to be vealed, valued at birth at $1.76 each, and 75 bulls to be sold, valued at birth at $4.15 each, born during the year.

On 94 farms, 368 calves were fatted and slaughtered or sold. The average value of calves fatted was $10.57 a head. On 97 farms 546 calves were sold to be fatted elsewhere, for an average price of $1.76 a head. These calves were sold when they were old enough to be taken away. The price received just equaled the value at birth.

In most cases no costs except for feed were obtained for veals and bulls to be sold. On a few farms some of the other costs were obtained, but it was found impracticable to endeavor to get this information for each farm. Accurate statements of the labor and other items of cost cannot be given because such costs are so small a part of those for the herd, but dependable estimates of the milk and other feed used can be furnished.

Amount and value of feed used, and miscellaneous costs and returns

The amount of milk used by bulls to be sold and that used in fattening veals was not kept separate on the records. The quantities of feed used per head were found by dividing the total amount of feed used by the total number of fat calves sold, slaughtered, or on hand plus the number of bull calves born and purchased during the year. By so doing it was found that 427 pounds of whole milk, 14 pounds of skimmilk, 3 pounds of grain and calf meal, and 4 pounds of dry forage, were used per veal or bull to be sold (table 139).

The total costs were \$7.04 a head, the total returns \$8.57 a head, and the difference \$1.53 a head. This cannot properly be called gain on calves, because the labor spent in their care, and other costs for this class of stock, were included with labor for cows.

TABLE 139. AMOUNT AND VALUE OF FEED USED, AND MISCELLANEOUS COSTS AND RETURNS, FOR VEALS AND BULLS TO BE SOLD

Number of farms fattening calves	94
Per cent of farms having calves to be vealed	69
Fat calves sold, slaughtered, or on hand	377
Bull calves to be sold, born and purchased during year	76
Total fat calves and bulls to be sold	453

Kind of feed	Number of pounds used	
	Total	Per head
Whole milk	193,535	427
Skimmilk	6,522	14
Grain and calf meal	1,350	3
Dry forage	1,800	4
Costs:		
Whole milk	\$3,126.91	\$6.90
Skimmilk	13.16	0.03
Grain and calf meal	23.00	0.05
Dry forage	11.00	0.02
Miscellaneous, and use of buildings	17.00	0.04
Total costs	\$3,191.07	\$7.04
Returns:		
Appreciation	\$3,876.00	\$8.56
Manure	4.50	0.01
Total	\$3,880.50	\$8.57
Difference	+\$689.43	+\$1.53

Size of herd and number of calves vealed

Calves fatted in larger herds are fed less milk. This, together with the fact that they are sold for less money, would suggest that they are disposed of at an earlier age. Various investigations have shown that the older a calf becomes, the more whole milk is required to produce a pound of gain. The milk used in making veal will furnish more energy than the veal it produces. Thus, from the public standpoint it is better to use the milk than to feed it to make meat.

It frequently happens that a number of cows in the herd freshen a few days apart. In such cases there is milk unfit for human use that may best be turned into money by transferring a veal calf from one cow to another. Sometimes calves fail to do well when so handled, but in the larger herds a number were fatted in this manner.

The very small herds fat a larger proportion of their veal calves than do the very large herds. This is to be expected since they follow a more extensive system. The prices received for calves sold to be fatted were higher in the larger herds. This is probably due to the size of the calf.

The relation of the size of herd to the proportion of veal calves fatted at home, the proportion sold to be fatted, and the prices received, are given in table 140:

TABLE 140. RELATION OF SIZE OF HERD TO PROPORTION OF VEAL CALVES FATTED AT HOME, PROPORTION SOLD TO BE FATTED ELSEWHERE, AND PRICES RECEIVED

Number of cows per farm	Fat calves sold or slaughtered, plus increase in inventory of fat veal calves				Calves sold to be fatted, or on hand			
	Number	Value: Total	Value: Per head	Per cent*	Number	Value: Total	Value: Per head	Per cent*
6 to 10	89	$ 949	$10.66	41	126	$196	$1.56	58
10+ to 14	132	1,450	10.98	53	106	168	1.58	42
14+ to 18	46	547	11.89	26	129	231	1.79	74
Over 18	110	1,064	9.67	37	187	372	1.99	63
All farms	377	$4,010	$10.64	40	548	$967	$1.76	58

*Of calves vealed or to be vealed born during the year, plus calves purchased to be vealed, 16, or 2 per cent, died after birth.

Calves vealed in three seasonal groups

The amount of milk used per veal was practically the same regardless of the season of milk production. A little more skimmilk was used in the summer dairies. The average value of milk used for veals in winter dairies was $1.70 per hundred pounds, while in summer dairies it was $1.52, or 18 cents less per hundred pounds. Thus, calves in summer dairies were fatted on cheaper milk, and accordingly the cost was slightly less. It is possible that in summer dairies some calves were fatted during the fall and winter, when milk was higher in price. But since this was not ascertained, it became necessary to charge milk at the average price for the year on each farm. In summer dairies, the returns exceeded the costs by $2.76 a head, while in winter dairies the difference was only 70 cents a head (table 141).

Altho in summer dairies fewer of the calves born are deaconed or vealed, the proportion of vealed calves fatted at home is higher than in winter dairies. In summer dairies, 44 per cent of the veal calves were sold to be fatted, and 54 per cent were fatted at home; while in winter dairies, 65 per cent were sold to be fatted, and only 34 per cent were fatted at home (table 142). Inasmuch as the time of year when the calves were fatted was not ascertained, it was assumed that most of those vealed in summer dairies were fatted in the spring and most of those vealed in the fall dairies were fatted in the fall. The price received for fatted calves was

much the same regardless of the season of milk production, but the average price received for those sold to be vealed was higher in winter dairies than in summer dairies.

TABLE 141. RELATION OF SEASON OF MILK PRODUCTION TO MILK AND FEED USED BY VEALS AND BULLS TO BE SOLD

	Per cent of milk sold during May, June, and July					
	Less than 33		From 33 to 40		More than 40	
Number of farms fattening calves	34		33		27	
Per cent of farms having calves to be vealed	67		67		73	
Fat calves sold, slaughtered, or on hand	129		139		109	
Bull calves to be sold, born and purchased during year	33		29		14	
Total fat calves and bulls to be sold	162		168		123	
Kind of feed	Total	Per head	Total	Per head	Total	Per head
Whole milk (pounds)	67,761	418	74,622	444	51,152	416
Skimmilk (pounds)	1,350	8	2,100	12	3,072	25
Grain and calf meal (pounds)	100	1	1,250	7	......	......
Dry forage (pounds)	......	......	....	......	1,800	15
Costs:						
Whole milk	$1,152.41	$7 11	$1,197.78	$7.13	$776.72	$6.31
Skimmilk	3 00	0.02	4 00	0.02	6.16	0.05
Grain and calf meal	3 00	0.02	20.00	0.12	....	......
Dry forage	......	......	....	......	11.00	0.09
Miscellaneous, and use of buildings	6.00	0 04	11.00	0.07	......	....
Total costs	$1,164.41	$7.19	$1,232.78	$7.34	$793.88	$6.45
Returns:						
Net increase	$1,274.00	$7.86	$1,469.00	$8.75	$1,133.00	$9.21
Manure	4.50	0 03	......	......	....	....
Total returns	$1,278.50	$7 89	$1,469.00	$8.75	$1,133.00	$9.21
Difference	+$114.09	+$0.70	+$236.22	+$1.41	+$339.12	+$2.76

TABLE 142. RELATION OF SEASON OF MILK PRODUCTION TO PROPORTION OF VEAL CALVES FATTED AT HOME, PROPORTION SOLD TO BE FATTED ELSEWHERE, AND PRICES RECEIVED

Per cent of milk sold during May, June, and July	Fat calves sold or slaughtered, plus increase in inventory of fat veal calves				Calves sold to be fatted, or on hand			
	Number	Value		Per cent*	Number	Value		Per cent*
		Total	Per head			Total	Per head	
Less than 33	129	$1,351	$10.47	34	244	$455	$1.86	65
From 33 to 40	139	1,521	10.94	38	217	383	1.76	60
More than 40	109	1,138	10.44	54	87	129	1.48	44

* Of calves vealed or to be vealed born during the year, plus calves purchased to be vealed, the remainder died after birth.

SUMMARY

The important quantities found for summer and winter dairies are summarized in table 143 in comparison with averages for all farms:

TABLE 143. SUMMARY OF QUANTITIES

	Less than 33 per cent of milk sold during May, June, and July	Average for all farms	More than 40 per cent of milk sold during May, June, and July
Size of business:			
Acres farmed	168	157	142
Acres pastured	57	53	52
Cows per farm	14.2	13.8	12.3
Heifers one year old or older	3.8	3.2	2.8
Heifers less than one year old	3.7	3.6	3.5
Cattle units	18.7	17.9	16.2
Hundredweight of milk produced per farm	830	764	645
Hundredweight of milk sold per farm	768	703	591
Season of milk production:			
Per cent of milk sold during:			
May, June, July	27	34	43
August, September, October	18	22	28
November, December, January	27	20	13
February, March, April	28	24	16
Month of maximum production	May	June	June
Month of minimum production	August	February	February
Production:			
Milk produced per cow (pounds)	5,822	5,532	5,255
Milk sold per cow (pounds)	5,392	5,089	4,815
Butterfat produced per cow (pounds)	234	222	215
Butterfat sold per cow (pounds)	217	204	197
Per cent of butterfat in milk	4.0	4.0	4.1
Manure recovered per cattle unit (tons)	8.2	7.7	7.2
Feeding:			
Cows:			
Acres of pasture per animal unit	3.1	3.1	3.4
Grain per cow (pounds)	1,668.0	1,407.0	1,140.0
Grain per cow per day during winter (pounds)	7.2	6.0	4.8
Silage per cow (pounds)	5,592.0	3,806.0	1,268.0
Silage per cow per day during winter (pounds)	26.3	18.1	6.2
Other succulent feed per cow	858.0	837.0	732.0
Other succulent feed per cow per day during winter (pounds)	1.8	1.5	1.1
Dry forage per cow (pounds)	4,265.0	4,162.0	4,437.0
Dry forage per cow per day during winter (pounds)	20.5	20.1	21.7
Silage per cow, farms using silage (pounds)	*7,961.0	7,272.0	†5,845.0
Silage per cow per day during winter, farms using silage (pounds)	*38.0	34.6	†27.6
Dry forage per cow, farms using silage (pounds)	*3,350.0	3,237.0	†3,005.0
Dry forage per cow per day during winter, farms using silage (pounds)	*16.1	15.5	†14.3
Dry forage per cow, no silage used	*5,916.0	5,167.0	†4,625.0
Dry forage per cow per day during winter, no silage used	*28.8	25.3	†22.7

*Less than 36 per cent of the milk sold during May, June, and July.
†36 per cent or more of the milk sold during May, June, and July.

TABLE 143 (*concluded*)

	Less than 33 per cent of milk sold during May, June, and July	Average for all farms	More than 40 per cent of milk sold during May, June, and July
Heifers:			
Whole milk fed per heifer calf	424	375	281
Skimmilk and buttermilk fed per heifer calf	204	235	257
Grain per cattle unit of heifers	589	531	445
Silage per cattle unit of heifers	1,746	1,234	389
Other succulent feed per cattle unit of heifers	31	100	171
Dry forage per cattle unit of heifers	3,558	3,207	3,092
Herd bulls:			
Whole milk fed per bull calf to be kept	456	392	325
Skimmilk and buttermilk fed per bull calf to be kept	118	138	194
Grain per cattle unit of herd bulls	720	533	417
Silage per cattle unit of herd bulls	2,391	1,430	481
Other succulent feed per cattle unit of herd bulls	27	52	18
Dry forage per cattle unit of herd bulls	4,062	3,430	3,077
Veals and bulls to be sold:			
Whole milk fed per veal and bull to be sold	418	427	416
Economy of production in terms of feed:			
Per 100 pounds of milk produced during pasture season:			
Days of pasture per cow	7.1	6.0	5.1
Grain (pounds)	6.2	5.2	4.3
Silage (pounds)	6.6	2.8	0.0
Other succulent feed (pounds)	22.0	20.2	16.4
Dry forage (pounds)	0.6	0.5	0.4
Per 100 pounds of milk produced in winter:			
Grain (pounds)	42.6	43.9	47.5
Silage (pounds)	151.9	129.0	59.9
Other succulent feed (pounds)	10.2	10.5	10.3
Dry forage (pounds)	118.5	143.5	209.1
Feed units	113.8	119.8	135.0
Per 100 pounds of milk produced for the year:			
Grain (pounds)	28.6	25.4	21.7
Silage (pounds)	96.1	68.8	24.1
Other succulent feed (pounds)	14.7	15.1	13.9
Dry forage (pounds)	73.3	75.2	84.4
Labor:			
Human labor:			
Hours per cow:			
Milking	96.3	90.1	89.0
Hauling milk	16.3	19.6	23.3
Other labor	86.2	77.7	73.7
Total hours	198.8	187.4	186.0
Hours per 100 pounds of milk produced	3.42	3.38	3.54
Hours per cattle unit of heifers	52.5	55.1	54.9
Hours per cattle unit of herd bulls	89.4	73.0	61.3
Horse labor:			
Hours of horse labor per cow, including milk hauling	29.8	33.9	39.1
Hours of horse labor per 100 pounds of milk produced, including milk hauling	0.51	0.61	0.74

C. U. F. M. Blank 41—Fig. 1

FINANCIAL RECORD OF A DAIRY HERD

A blank arranged for calculating separately the costs and returns for the entire dairy herd, for cows, for heifers, for herd bulls, for calves vealed and for bulls raised to sell.

Prepared by Department of Farm Management, New York State College of Agriculture, at Cornell University, Ithaca, N Y

Record for the year ending ____________ 19 ____ Date __________ 19 ____ Herd number __________ Number used in tabulating ________

Dairyman's name ____________________ Age ______ Post Office ____________ R D ________ County ________ State ____

Acres farmed __________ Acres owned ________ Acres share rented ______ Acres cash rented ____________ Acres of crops __________

Miles to milk station ______________ Elevation of farm __________ feet. Located on upland or in a valley ______________

HOME GROWN FEED AND BEDDING USED DURING THE YEAR BY DAIRY CATTLE

	TOTAL HERD			COWS PASTURE PERIOD				COWS WINTER PERIOD				HEIFERS		HERD BULLS		BULLS TO SELL	
	Amount	Price	Value			Amount	Value			Amount	Value	Amount	Value	Amount	Value	Amount	Value
GRAIN Corn																	
Oats																	
Barley																	
Buckwheat																	
SUCCULENT FEED Corn silage																	
Mangels																	
Cabbage																	
Soiling crops( )																	
DRY FORAGE Corn stover																	
Timothy hay																	
Mixed hay																	
Clover hay																	
Alfalfa hay																	
Rowen																	
Oat hay																	
Oat and pea hay																	
Millet hay																	
Straw fed ( )																	
BEDDING Straw ( )																	
Straw ( )																	
Other bedding ( )																	

*PURCHASED FEED AND BEDDING USED DURING THE YEAR BY DAIRY CATTLE

	TOTAL HERD			COWS PASTURE PERIOD				COWS WINTER PERIOD				HEIFERS		HERD BULLS		BULLS TO SELL	
	Amount	Price	Value			Amount	Value			Amount	Value	Amount	Value	Amount	Value	Amount	Value
GRAIN *Less than 12 per cent protein*																	
Beet pulp																	
Corn meal																	
Ground oats																	
Hominy																	
Molasses																	
Molasses feeds																	
12–25 per cent protein Calf meal																	
Wheat bran																	
Wheat feed																	
Wheat middlings																	
Over 25 per cent. protein Brewer's grains																	
Cottonseed meal																	
Distiller's grains																	
Gluten feed																	
Oil meal																	
SUCCULENT FEED( )																	
DRY FORAGE Hay ( )																	
Corn stalks																	
BEDDING Straw																	
Shavings																	
Sawdust																	
Other bedding																	
TOTALS																	
Grain																	
Silage																	
Other succulent feed																	
Dry forage																	
Skim milk purchased				X	X	X	X	X	X	X	X						
TOTAL FEED	X	X				X				X		X		X		X	
Bedding																	

Average value of feed and supplies kept on hand for cattle } $ ________ Interest $ ________ Charge: Cows $ ________ Heifers $ ________ Herd bulls $ ________ Bulls to sell $ ________

*Divide pounds of wet brewer's grains by 3.8 and list as dried grains. Divide wet beet pulp by 9 and list as dried beet pulp. If purchased skim milk or other feed is used for veals note wherever convenient.

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LABOR FOR DAIRY CATTLE

	Human Hours								Horse Hours					
	Total	Cows Pasture	Cows Winter	Total Cows	Heifers	Herd Bulls	Bulls to Sell	Veals	Total	Cows	Heifers	Herd Bulls	Bulls to Sell	Veals
Milking—Man														
Woman or child														
Feeding and care of cattle and care of utensils and product: Man,														
Woman or child														
Extra time hauling feed														
Hauling bedding														
Hauling or carrying water														
Hauling sawdust for ice														
Harvesting and storing ice														
Buying, selling, and collecting feed, cattle and supplies														
Taking cows or heifers to breed														
Cleaning and whitewashing														
Herding														
Mixing feed														
Testing and accounting														
Washing suits and towels														
Other labor														
TOTAL HOURS														
TOTAL VALUE														

PASTURE

Pasture begins ______ Ends ______ Days ______

Number of acres pastured ______

Average value per acre $ ______ Total value $ ______

Costs	Amount	Price	Value
Interest @ %			
Taxes			
Paid for pasture			
Charge for pasturing meadows			
Posts			
Barbed wire			
Woven wire			
Staples			
Seed			
Lime			
Fertilizer			
Manure hauled and applied			
Man Labor: Making and repairing pasture fences			
Mowing, reseeding, fertilizing and manuring pastures			
Other Man Labor			
Horse Labor: Making and repairing pasture fences			
Mowing, reseeding, fertilizing and manuring pastures			
Other Horse Labor			
Other costs			
TOTAL COST			$

DISTRIBUTION OF PASTURE COST

Stock Pastured	No.	Days Pastured	Equivalent in Animal Units for the Entire Season	Per Cent of Cost to be Borne by Each	Am't Charged
Cows					$
Heifers, 1 yr. or over					
Heifers under 1 yr					
Herd bulls					
Bulls to sell					
Animal units of other stock					
TOTAL	X	X		100.	$

Average rate paid for pasture ______

Average wages per month, including board ______

BUILDINGS USED FOR CATTLE

Inventories	Value Beginning	Value End
Dairy cattle barns and yards and buildings for storing equipment used for cattle		
Silos X		
Milk house		
Ice house		
Share of pump house		
TOTAL	$	
AVERAGE VALUE		$

Costs	Amount	Price	Value
Interest @ %	X	X	
Insurance	X	X	
Taxes	X	X	
Decreased value	X	X	
Purchased lumber			
Shingles			
Roofing			
Hardware			
Paint			
Glass			
Sand			
Gravel			
Cement			
Stanchions			
Wire netting			
Lightning rods			
Materials from farm			
Carpenter's, painter's, mason's or other labor hired for building work			
Board of this labor			
Farm labor			
Horse labor			
Other costs			
TOTAL			$
Less increased value, if any			
TOTAL COST			$

DISTRIBUTION OF BUILDING COST

	Per cent. of Total Number of Cattle Units	Amount Charged
Cows		$
Heifers		
Herd bulls		
Bulls to sell		

EQUIPMENT USED FOR CATTLE

	Value Beginning	Value End	Purchased Amount	Purchased Value	Cost of Repairs
Cans					
Coolers					
Tester, bottles, etc					
Milk or feed scales					
Separator					
Churn and butter worker					
Milk pails and strainers					
Milking machine					
Milk wagons					
Share of farm auto					
Boilers					
Gasoline or steam engines					
Feed grinders					
Water pumps					
Water tanks					
Water heaters					
Share of other water system					
Share of lighting system					
Ice tools					
Feed trucks					
Litter carriers					
Wheelbarrows					
Clipping machine					
White washing outfit					
Milking tubes, milk fever, and other veterinary outfits					
Baskets					
Brooms					
Forks					
Shovels					
Sprayers					
Curry combs and brushes					
Rope					
Halters					
Bull staffs and rings					
Lanterns					
Calf pails					
Milking stools					
Wash basins					
Thermometers					
Labor Man—hours	X	X	X	X	
Horse—hours	X	X	X	X	
Other items					
TOTAL	$			X	$

Received for equipment sold $ ______

AVERAGE VALUE OF EQUIPMENT $ ______ Interest $ ______

Decreased value $ ______ Increased value $ ______

CHARGE FOR THE USE OF EQUIPMENT Interest, purchases and repairs plus decreased value or less increased value and equipment sold $ ______

CHARGE: Cows $ ____ Heifers $ ____ Herd bulls $ ____ Bulls to sell $ ____

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INVENTORIES, PURCHASES, SALES AND DEATHS OF DAIRY CATTLE

	Inventory at Beginning of Year			Purchased During Year			Slaughtered or Sold for Slaughter			Sold for Breeding and Production			Inventory at End of Year			Died	Hides Sold	
	No.	Price	Total	No.	Price	Total	No.	Price	Total	No.	Price	Total	No.	Price	Total	No.	No.	Value
Cows																		
Heifers, 1 yr. or over, not fresh																		
Heifers under 1 yr. to be raised																		
Calves to be vealed																		
Bull calves to be sold																		
Bull calf to be kept																		
Bulls 1 to 2 years																		
Bulls over 2 years																		

CALVES BORN DURING THE YEAR

	Number	Value per Head at Birth	Total Value
Heifers vealed or to be vealed		$	$
Heifers raised or to be raised			
Bulls vealed or to be vealed			
Bulls to be kept			
Other bulls sold or to sell			
			Value of Hides and Carcasses
Calves born dead, aborted			
Calves born dead, not premature			
Heifers deaconed			
Bulls deaconed			
TOTAL			

Number of good heifers from good cows that were vealed____deaconed____

Heifers that freshened during the year for the first time.

Number ______Average value just before calving $______

Total value $ ______Average age at time of calving ______months.

Number of farrow cows ______

APPRECIATION OR DEPRECIATION ON CATTLE

Charge cows with inventory at beginning, purchases and heifers that freshened during the year for the first time. Credit cows sold or slaughtered, cow hides sold, and inventory at end. An excess of charges is the depreciation, or an excess of credits the appreciation on cows.

Charge heifers with inventories at beginning, purchases, and heifers born during year. Credit heifers sold or slaughtered, heifer hides, heifers that freshened during the year for the first time, and inventories at end, to get appreciation or depreciation.

Charge herd bulls with inventories at beginning, purchases, and value at birth of bull to be kept. Credit herd bulls sold or slaughtered, sales of hides and inventories at end, to get appreciation or depreciation.

Do the same with bulls to sell and veals as with heifers or herd bulls, to get appreciation or depreciation.

	Appreciation	Depreciation
	$	$
Cows		
Heifers		
Herd bulls		
Bulls to sell		
Veals		
TOTAL		
NET		

AVERAGE INVENTORY AND INTEREST

	Number	Cattle Units	Value	Interest
			$	$
Cows				
Heifers				
Herd bulls				
Bulls to sell				
Veals				
TOTAL				

MILK HAULING

	Hauls	Coöperates	Hires
Trips			
Miles			
Man hours			X
Woman or child hours			X
Horse hours			X
Value human labor	$	$	X
Value horse labor			X
Amount paid @ per cwt.	X	X	$
Received for hauling milk	X	X	$
COST OF MILK HAULING	$		
NET			$

MISCELLANEOUS COSTS FOR CATTLE

	Total Herd		Cows	Heifers	Head Bulls	Bulls to Sell	Veals
	Amount	Value					
Insurance on cattle		$	$	$	$	$	$
Taxes on cattle if any							
Condimental feeds							
Salt							
Vaseline, salves, salts and other medicines							
Disinfectants							
Tuberculin testing							
Dehorning							
Veterinary fees							
Louse killers							
Fly killers							
Tangle foot							
Lime							
Kerosene							
Carbide							
Electric lights							
Gasoline							
Oil							
Batteries for engines							
Fuel for water heater							
Fuel for dairy							
Soap and cleaning powders							
Towels, suits, strainer cloths, and muslin for windows							
Acid							
Testing dues							
Board of tester							
Board of testers horse							
Board of cattle buyers							
Freight or express on cattle							
Feed grinding							
Paid for hauling feed, bedding, ice or sawdust for ice							
Paid for ice							
Sawdust for ice							
Association dues							
Dairy papers							
Postage							
Stationery							
Printing and advertising							
Herdbooks or other records							
Registration fees							
Transfer fees							
Commissions, affidavits and shipping tags							
Railroad fares							
Telephone							
Telegrams							
Weighing							
Breeding fees							
Other costs							
					X	X	
TOTAL							

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MILK AND ITS PRODUCTS SOLD

Market milk sold to at

	Cows Calving	Fat Test	Pounds of Fat	Amount	Per cent.	Price	Total Value
PASTURE PERIOD May /31						$	$
June							
July							
August							
September							
October /31							
TOTAL							
WINTER PERIOD October /31							
November							
December							
January							
February							
March							
April							
May /31							
TOTAL							
TOTAL MARKET MILK SOLD							
Milk retailed							
Butter							
Cream							
Skim milk							
Butter milk							
Other milk products							
TOTAL MILK AND ITS PRODUCTS SOLD							

SUMMARY OF COSTS AND RETURNS

	From Page	Total Herd	Cows	Heifers	Herd Bulls	Bulls to sell	Veals
COSTS Feed	1	$	$	$	$	$	$
Milk and its products produced on the farm and fed to cattle	4	X	X				
Pasture	2						
Bedding	1						
Human labor	2						
Horse labor	2						
Buildings	2						
Equipment	2						
Depreciation on cattle	3						
Interest on cattle	3						
Interest on feed and supplies	1						
Milk hauling	3						
Miscellaneous	3						
Loss on herd bulls	4	X			X	X	X
TOTAL							
RETURNS Gain on herd bulls	4	X			X	X	X
Calves born during the year	3	X		X	X	X	X
Appreciation on cattle	3						
Manure	4						
Milk and its products sold	4			X	X	X	X
Milk and its products used on the farm*	4			X	X	X	X
Miscellaneous	4						
TOTAL							
Gain							
Loss							
Returns other than milk sold							
Cost of milk at market				To get cost of milk at market subtract returns other than milk sold from total costs.			

BREED OF CATTLE

	Breed	Number Registered	Average Weight	Average Years Milked
Cows				
Heifers 1 yr. or over			X	X
Heifers under 1 yr			X	X
Herd bulls			X	X
Bulls to sell	*		X	X

Years pure bred bull used . Does dairy man weigh milk daily? . If not how often? . Was herd in cow testing association for the year of this record?

*Do not include value of milk and its products used by cattle under total herd.

†A therm as here used is the measure of energy in a feed, available for maintenance and production.

MILK AND ITS PRODUCTS USED ON THE FARM

	WHOLE MILK				SKIM MILK			BUTTER MILK			Butter	Cream
	No. to which fed	Price at which charged	Pounds	Value	No. to which fed	Pounds	Value	No. to which fed	Pounds	Value		
Heifers											X	X
Bulls to be kept											X	X
Bulls to sell											X	X
Calves vealed											X	X
Poultry	X	X	X	X	X			X			X	X
Hogs	X	X	X	X	X			X			X	X
Family use	X				X			X				
Hired men	X				X			X				
TOTAL		X										
Price	X	X	X	X	X	X		X	X			

Total value of milk and its products used on the farm $ ________ Value $ ________

Fed cattle $ ________ Heifers $ ________ Bulls to be kept $ ________ Bulls to sell $ ________ Calves vealed $ ________

MISCELLANEOUS RETURNS FOR CATTLE

	Total	Cows	Heifers	Herd Bulls	Bulls to sell
Insurance	$	$	$	$	$
Premiums					
Board of cows					
Breeding fees					
Feed bags					
Other receipts					
TOTAL					

Total pounds of milk used ________

Total pounds of milk produced ________

Total pounds of butter fat used ________

Total pounds of butter fat produced

MANURE RECOVERED FROM CATTLE

	Tons	Price	Value
Cows			$
Heifers			
Herd bulls			
Bulls to sell			
TOTAL			

FACTORS FOR ANALYZING AND STUDYING THE RECORD

	THIS HERD		AVERAGE FOR REGION	
	Amount or Number	Value or Per cent.	Amount or Number	Value or Per cent.
SIZE OF THE DAIRY ENTERPRISE				
1 Acres farmed		X		X
2. Number of cows		X		X
3. Number of heifers		X		X
4. Milk sold	cwt.	$	cwt.	$
FACTORS INFLUENCED BY SIZE				
5 Labor per cow	hrs.		hrs.	
6. Labor per cattle unit of heifers				
7 Building investment per cattle unit	X		X	
8. Building costs per cattle unit	X		X	
9 Milk hauling per cow	hrs.		hrs.	
10 Milk hauling per hundred weight				
11. Total profit on dairy cattle	X		X	
SEASON OF MILK PRODUCTION				
12 Market milk sold in pasture period	cwt.	%	cwt.	%
13. Market milk sold in winter period		%		%
14. Cows calving in spring months of		%		%
15 Cows calving in fall months of		%		%
PRODUCTION PER COW				
16. Milk sold per cow	lbs.	$	lbs.	$
17 Milk produced per cow	lbs.		lbs.	
18. Butter fat in milk produced per cow	lbs.	X	lbs.	X
FEEDING				
19. Grain fed cows per cow	lbs.	$	lbs.	$
20. Silage fed cows per cow	lbs.		lbs.	
21. Dry forage fed cows per cow	lbs.		lbs.	
22. Value of feed except pasture per cow	X		X	
23. †Per cent. of therms in grain of winter ration from feeds containing over 25 per cent. protein	X	%	X	%
24. Grain per cattle unit of heifers	lbs.		lbs.	
25. Grain per cattle unit of herd bulls	lbs		lbs.	
ECONOMY OF PRODUCTION AND PROFITS				
26. Herd cost of milk per hundred weight	X		X	
27. Cow cost of milk per hundred weight	X		X	
28. Cow cost per pound of butter fat	X		X	
29. Total costs per cow	X		X	
30. Total returns per cow	X		X	
31. Profit per cow	X		X	
32. Total cost of heifers per cattle unit	X		X	
33. Appreciation on heifers per cattle unit	X		X	

ECONOMY OF WINTER PRODUCTION	Per 100 lbs. of milk produced	Per lb. of butter fat produced	Per 100 lbs. of milk produced	Per lb. of butter fat produced
Hours of labor				
Grain				
Silage				
Other succulent feed				
Dry forage				
TOTAL FEED				

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Studies on Insects Affecting the Fruit of the Apple

With Particular Reference to the Characteristics of the Resulting Scars

Harry Hazelton Knight

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CONTENTS

STUDIES ON INSECTS AFFECTING THE FRUIT OF THE APPLE, WITH PARTICULAR REFERENCE TO THE CHARACTERISTICS OF THE RESULTING SCARS [1]

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During the season of 1914 the writer began an extensive series of observations on the production and development of scars induced by the various insects attacking the apple. The ultimate aim of this work was to make it possible to determine from the characters of the scars on the apples at picking time what insects had caused them, so that the orchardist might deal more intelligently with these obscure foes. The writer was able to carry on this work under most favorable circumstances in cooperation with the Genesee County Fruit Growers' Association, spending all his time during four growing seasons in orchards throughout Genesee County. Extensive data were obtained on the scars and blemishes caused by all of the well-known injurious insects affecting the fruit of the apple, and detailed observations and photographs were made of the work of several species that are scarcely to be recognized from the scars they produce. New and little-known types of scars were studied, particularly those caused by the apple redbugs *Lygidea mendax* and *Heterocordylus malinus*. The scars caused by these bugs were found to develop differently according to the variety of apple affected and the time of puncture with reference to the growth of the fruit. Several species of lepidopterous larvae are known to injure the fruit of the apple, and comparative studies were made of fifteen different species and photographs were obtained showing the chief characteristics of their work and the resulting scars. In all, thirty species of insects, representing five orders, were found attacking the fruit of the apple in western New York, and comparative studies show that with sufficient observation and experience a large proportion of all the blemishes and scars found on apples at picking time may be correctly referred to the insects causing them. Comparative studies with an extensive series of photographs were made of the scars and blemishes caused by agencies other than insects, particularly by spray injury, mechanical injuries, apple scab, frost, and hailstones.

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INSECTS STUDIED

The species of insects studied were the following:

Hemiptera:

1. The light apple redbug (*Lygidea mendax* Reuter)
2. The dark apple redbug (*Heterocordylus malinus* Reuter)
3. The colon apple leaf bug (*Paracalocoris hawleyi pallidulus* McAtee)
4. The clouded apple leaf bug (*Neurocolpus nubilus* Say)
5. The rosy apple aphid (*Aphis sorbi* Kaltenbach)
6. The apple leaf aphid (*Aphis pomi* De Geer)
7. The San José scale (*Aspidiotus perniciosus* Comstock)
8. The oyster-shell scale (*Lepidosaphes ulmi* Linnaeus)
9. The scurfy scale (*Chionaspis furfura* Fitch)

Lepidoptera:

1. The codling moth (*Carpocapsa pomonella* Linnaeus)
2. The lesser apple worm (*Enarmonia prunivora* Walsh)
3. The fruit-tree leaf roller (*Archips argyrospila* Walker)
4. The oblique-banded leaf roller (*Archips rosaceana* Harris)
5. The green fruit worm (*Xylina antennata* Walker)
6. The green fruit worm (*Xylina laticinerea* Grote)
7. The red fruit worm (*Rhynchagrotis placida* Grote)
8. The white-marked tussock moth (*Hemerocampa leucostigma* Smith and Abbot)
9. The palmer worm (*Ypsolophus ligulellus* Hübner)
10. The bud moth (*Tmetocera ocellana* Schiffermüller)
11. The red-banded leaf roller (*Eulia velutinana* Walker)
12. The pistol case-bearer (*Coleophora malivorella* Riley)
13. The cigar case-bearer (*Coleophora fletcherella* Fernald)
14. The fall webworm (*Hyphantria textor* Harris)
15. The apple serpentine miner (*Marmara pomonella* Busck)

Coleoptera:

1. The plum curculio (*Conotrachelus nenuphar* Herbst)
2. The apple curculio (*Anthonomus quadrigibbus* Say)
3. The rose chafer (*Macrodactylus subspinosus* Fabricius)

Diptera:

1. The apple maggot (*Rhagoletis pomonella* Walsh)

Hymenoptera:

1. The apple-seed chalcis (*Syntomaspis druparum* Boheman)
2. The dock false-worm (*Ametastegia glabrata* Fallén)

METHODS OF STUDY

In conducting the observations, large shipping tags were used to keep track of the injured apples. On these tags were written all data regarding the time of injury, and subsequently additional notes were added concerning the development of the scars. Large numbers of apples were tagged for each species of insect found at work in the various orchards,

and at short intervals throughout the growing period specimens were picked and photographed so that a record might be kept of each kind of injury in its various stages of development. Where it was desirable to cage insects on the limb with the fruit — as, for example, to find what injuries a particular larva, nymph, or adult might produce, or to prevent other insects from adding scars to the experiment — a coarsely woven fabric called *tarlatan* was used for inclosing the limb and fruit. This material allows sunlight and rain to pass through readily, thus permitting normal growth, whereas the use of cheesecloth or other heavy and coarsely woven material was found to be detrimental to growth, causing the leaves to drop and the fruit to remain stunted.

For convenience in carrying out the photographic work, a small laboratory, equipped with dark room and skylight, was erected in one of the orchards (Plate III). Here the work was carried out to better advantage than would have been possible with the camera at some distant point. This laboratory consisted of a frame structure, 10 by 12 feet in area by 9 feet in height at the ridgepole, with sides screened and the roof covered with a light canvas except for one-half of the south exposure, which was fitted with glass to form a skylight. The dark room, 5 by 5 feet in area by 6 feet in height, occupied the rear corner opposite the operating table and skylight, and was made lightproof by several thicknesses of tar paper tacked over a framework containing a door with a passageway. A thick, dark ruby glass, set in one side as a window, furnished all the necessary lighting, thus completing a very simple but effective dark room.

GROWTH OF FRUIT IN RELATION TO TIME OF INJURY A FACTOR IN THE TYPE OF SCAR DEVELOPED

The amount of injury in an orchard as measured by the proportion of injured fruits at picking time, and the types of scars produced, depend on several factors. When there is a heavy set of fruit, it is always the weak and injured fruits that drop first; the fruits that get a strong start and are free from injury are the ones that survive. In years when there is a heavy set, therefore, the redbugs and the leaf-roller larvae may actually help to thin the fruit without leaving a noticeable proportion of scarred fruits, since it is the injured apples that drop in the thinning process. If the season is favorable to very rapid growth following the blooming period, a larger proportion of injured fruits will recover and grow to maturity than in a year when growth is slow following the bloom. In a year when there is a light set of fruit and the period of growth is favorable to rapid development, the conditions are right to produce the largest proportion of scarred fruit at picking time, since by forced growth many

weak and injured fruits are able to develop that otherwise would have dropped. Any condition that tends to force the growth of the tree will enable more of the injured and weak fruits to grow and recover. The writer soon learned to thin the fruit on the limbs on which he was tagging apples that were being injured by an insect; if this were not done, it was found that about 95 per cent of the fruits tagged would drop and the experiment would be lost.

Certain varieties of apples are more subject to fatal injury than are others. Apples that grow to a large size, such as the Twenty Ounce and the pippin varieties, develop rapidly and can withstand or recover from wounds such as would cause a slow-growing variety to drop. The Northern Spy is a variety that develops slowly following the set of the fruit, and thus the injured fruits are more likely to drop. Strong vitality in the development of the fruit is particularly noticeable in pippin and Twenty Ounce apples injured by larvae of the fruit-tree leaf roller. These fruits may have part of the core eaten out and still develop to maturity, showing the remains of the core tissue at the bottom of the wound.

It was found that different varieties of apples would develop different kinds of scars when attacked by the same insect, this being particularly true in the case of the apple redbugs. Fruits that are punctured when very small and growing rapidly develop a different type of scar from that produced on apples that are attacked at a more mature stage. If the core of the young apple is punctured by feeding redbugs, the flesh of the fruit never grows back at the point of puncture and a deep pit results in the mature apple (Plate IV, 4). Later, when the fruit is of such size that the insect is unable to reach the core, the flesh will develop beneath the point of puncture and tend to reduce the depth of the pit. When the growth is sufficiently rapid, the pit may disappear entirely and a spreading russet scar take its place. After the apples have reached more than a quarter of an inch in diameter, growth is very rapid, and the punctures made by redbugs cause a splitting of the fruit skin which continues to enlarge with the growth of the apple until broad russet scars result (Plates IV, 3, VII, 20 and 21, and VIII, 22). Wounds made later in the season do not heal so readily as do those made while the fruit is expanding by rapid growth early in the season. Wounds made after the middle of July never heal with a clean scar, but become covered with a thick, corky layer formed by the dead and dried cells of the fruit. In the case of these later injuries, which are usually produced by the tussock moth or the plum curculio, the maturing date of the variety has much to do with the healing of the wound. Early-maturing varieties do not heal the wounds made after growth is nearly completed, and in many cases brown rot results.

NATURE OF INJURIES CAUSED BY DIFFERENT SPECIES

HEMIPTERA

The order Hemiptera includes all of the true bugs, and in the present study all the hemipterous insects discussed come within the families Miridae, Aphididae, and Coccidae. The Hemiptera develop by gradual metamorphosis, and thus the nymphs, in their feeding habits and activities, are similar to the adults. Both nymph and adult puncture the fruit by means of a long proboscis and suck juices from the tender tissue. In most cases the injuries by the adult are little different from the work of the nymphs except in point of time, and any difference that may be noted is due to the difference in the stage of growth of the fruit as related to the time when the puncture is made.

The light apple redbug
(*Lygidea mendax* Reuter)

The nymphs of *Lygidea mendax* begin hatching just as the blossom buds separate at the tips, and most of them have entered the second instar by the time the blossom buds show pink and are ready for the first scab spray. The nymphs are in the third instar while the trees are in bloom, and most of them have entered the fourth stage by the time the petals have fallen. It is during the fourth and fifth instars that the greatest amount of damage is done, or from the time when the petals fall to the time when the young apples are one-half inch in diameter. In 1914, which was a normal growing season, the adults of *Lygidea mendax* were maturing rapidly by June 18, and practically all were mature by June 22. The adults feed on the fruits extensively for a week or more, and then, as the fruits get larger and become tough, they begin feeding more on the tender shoots that develop.

When the redbug nymphs first begin feeding on the young fruit, the tissue of the core is usually punctured. In a short time, however, the fruit has increased in size to such an extent that the insect's proboscis is no longer able to reach the core tissue. Redbug punctures that penetrate the core develop a very different type of scar from those made at a later period. When the core tissue is punctured, the fleshy part of the apple grows up around the point of puncture, leaving a deep pit where the injury occurred; this is shown in Plate V, 7, a photoghraph made ten weeks after the fruit was punctured. Such apples invariably develop deep-sunken pits, as shown in the mature Northern Spy apples in Plates V, 8, and VI, 12. Of the varieties observed by the writer, the Northern Spy is the slowest in developing size in the fruit, and thus a higher proportion of deeply pitted apples is found in that variety. The Rhode Island *Green-*

ing and the Baldwin apples develop more rapidly following the set of the fruit, and hence the time is shorter during which the insects may reach the core and produce the deep wounds; this results in a smaller proportion of deeply pitted apples (Plate V, 9) and a greater number of the russet-scar type.

The irregular russet scars that have been so little understood are developed from punctures made just after the apple has become too large for the insect to reach the core with its beak and while the fruit is growing rapidly. In Plate IV, 1, Rhode Island *Greening* fruits are shown with nymph and adult redbugs, at a time when the core may no longer be reached (June 18) but at a period when the feeding punctures will produce ultimately the peculiar russet scars shown in Plates IV, 3, VII, 20 and 21, and VIII, 22. These young apples (Plate IV, 1) show injuries produced by feeding punctures made on June 10 and 11. The smaller apple shows in two or three places that the core was penetrated when the bug inserted its proboscis, while the larger one had passed that stage before the injury was made. When the fruit is first punctured the sap runs out freely, this being followed by the development of a thick gelatinous covering to the wound the edges of which turn white after a few hours. In two or three days the wound becomes rusty brown, and if the apple is growing rapidly the skin splits and thus enlarges the wound (Plate V, 5 and 6). It is the late injuries, made when the apple is growing most rapidly, that spread into the broad, shallow, russet scars. In many cases, even when punctured early the apple recovers so completely that no depressions result and only the broad, irregular russet scars are seen (Plates IV, 3, VI, 13, and VIII, 22 and 23).

Northern Spy apples punctured by the feeding bugs between June 12 and 14 were photographed when examined on July 8, at which time the characteristic splitting of the skin was well developed about the wounds (Plate IV, 2). The condition of the apple shown in this figure is almost an exact duplication of the condition on July 8 of the Northern Spy apple shown in Plate IV, 3. The mature apple shows how the scars have run together and healed to such an extent that no depressions have been formed. Baldwin apples punctured between June 10 and 18 were examined on July 3, at which time they showed the characteristic splitting of the skin about each of the punctures. This condition is well illustrated in Plate V, 6. It is at this age that the scars very much resemble certain developments of apple scab (Plate VII, 18). In Plate VI, 14, is shown a Rhode Island *Greening* apple (photographed on July 7) in which the scars are just developing but will soon spread and take on a russet character. Red Astrachan apples, being an early variety, develop more

rapidly than do standards, and thus the scars on that fruit will have on a given date a more advanced character than on the Baldwin, Rhode Island *Greening*, and Roxbury apples.

Very soon after the adult bugs emerge, or by June 25 to 27, the apples have attained such size and the growth is so gradual that the punctures made by the bugs do not split and enlarge as do the punctures made earlier. In Plate VI, 10 and 11, is shown the effect of late feeding of adult bugs, which may result in mere dimples or in tiny russet spots, depending much on the variety affected. The spots on the apple shown in Plate VI, 10, resemble very closely the dimples caused by the deposition of eggs by the apple maggot fly; but if they were the work of the latter, a cross section of the puncture would show either where the egg was placed or the winding trail of the maggot leading from it. The work of the apple-seed chalcis (*Syntomaspis druparum*) may resemble the work of apple maggot flies or very late-feeding punctures of redbugs, but in injury by the chalcis the larvae of the fly may be found in the seeds or a careful section will show the slender, straight trail of the ovipositor leading to the seeds (Plate XXXIV, 142).

Roxbury and Golden Russet apples are subject to injury by redbugs. The pitted and russet types of injury resulting on Roxburys are shown in Plate VII, 19, while the work on Golden Russets (July 13) is shown in Plate VI, 15. The early injuries produce deep pits, while the latest punctures cause russet scars that may frequently be hard to distinguish from the normal appearance of those varieties. In Plate VIII, 23, is shown a mature Roxbury apple injured by fifth-stage nymphs between June 15 and June 18, on which the russet scars healed so evenly with the normal surface that the apple would probably have passed inspection as Grade A fruit. The Baldwin apple shown in Plate VIII, 22, is perfectly shaped, but it has the characteristic russet scars developed from the late-feeding punctures of redbugs. In Plate VII, 21, is shown a mature but stunted Baldwin apple, which recovered from injuries of the feeding bugs although the adjoining fruit was so badly punctured that it died and shriveled up but still clung to the tree. Scars from late feeding were observed on Bough apples, these being very similar to scars found on Champlain and other early varieties. Russet scars caused by redbug punctures on Detroit Red apples were found to be very conspicuous on the dark skin of that variety. The same type of scars is shown on St. Lawrence apples (Plate VI, 13), and in this case the original rough scars, noted in July, changed to a smooth, brassy surface on the mature fruit.

The appearance of redbug scars differs according to the variety and is most interesting in some of the unnamed apples. In Plate VII, 20, are

shown the very conspicuous russet scars produced on an unnamed variety having a light-colored transparent skin. Certain of the slow-growing natural fruits do not split about the wound and develop the enlarged scars that occur in varieties having more rapid growth. Typical stages of redbug work are seen on the young natural fruits shown in Plate VI, 16 (photographed on July 6). *Lygidea mendax* was found breeding also on quince, where the bugs feed on the fruits and produce typical scars (Plate IX, 27) which in some cases might be mistaken for the work of the quince curculio.

Numerous fruits were tagged in the process of following the work of redbugs on the several varieties of apples, and in a few cases photographs were made of the young injured apple on the tree and again when the fruit was mature.

Redbug injury combined with injury by the rosy aphid

Under certain conditions the rosy aphid (*Aphis sorbi*) may develop and feed on apples injured by redbugs. When this occurs, the scars started by the redbugs are much enlarged and otherwise changed by the aphids (Plate VIII, 24). The work of the rosy aphid on apples tends to stunt the fruit as well as to cause it to become badly misshapen. The redbug punctures affected by aphids develop a wound having an ugly white frothy scab, which may eventually heal and produce a badly gnarled fruit. In Plate VIII, 25, are shown two mature Rhode Island *Greening* apples which on June 25 appeared exactly as did the injured fruits shown in Plate VIII, 24.

Varieties of apples injured by Lygidea mendax

The varieties of apples most affected by *Lygidea mendax* in Genesee County are here given in the order of greatest injury suffered: Rhode Island *Greening*, Northern Spy, Baldwin, Roxbury, Tolman, Tompkins King, Maiden Blush, Twenty Ounce, Esopus, Fall Pippin.

The dark apple redbug
(*Heterocordylus malinus* Reuter)

The dark apple redbug (*Heterocordylus malinus*) develops from seven to ten days earlier than does *Lygidea mendax*, and this makes considerable difference in its ability to injure apples. The nymphs hatch with the unfolding of the leaves, and feed on the tender foliage and to a slight extent on the fruit before reaching maturity. In a few cases the adult bugs have been observed to feed on the fruit, but all fruits so attacked dropped within a short time. It is apparent that in the case of most

varieties of apples the insects have practically finished feeding before the fruit is large enough to withstand the injuries of the bugs and remain on the trees; therefore, most of the injured fruits drop, and very few reach maturity with their scars.

In trying to get definite data on the work of this species, the writer carried out in 1915 no less than forty experiments, each of which consisted of isolating two fourth- or fifth-stage nymphs on an apple branch which was blooming and setting fruit. This was accomplished by using, as cages, bags made of tarlatan, which were drawn up around the limb and firmly tied. The nymphs invariably preferred to feed on the tender foliage instead of on the fruit. The few fruits that were punctured by the bugs did not survive the June drop and thus were lost.

The adults of this species (Plate IX, 26) are mature and have begun to lay eggs by the time the fruit is large enough to be injured, and thus their opportunity for doing harm is not so great as is that of *Lygidea mendax*. Redbug injury on Twenty Ounce apples which developed on a tree infested by *Heterocordylus malinus* and which the writer believes to be the work of that species, is shown in Plate IX, 28. The Twenty Ounce and pippin apples are, by the nature of their rapid development, the most likely to attain the size necessary to withstand the feeding punctures of the bugs and thus to develop mature scars from this species. It appears certain that in western New York the work of *Heterocordylus malinus* in producing knotty fruit is very limited or entirely absent on the standard varieties of apples.

The colon apple leaf bug
(*Paracalocoris hawleyi pallidulus* McAtee)

One of the leaf bugs which was frequently found breeding on apple was *Paracalocoris hawleyi pallidulus*, a form that usually develops on the tender shoots about the roots and the trunk of the tree. When abundant it may move to the branches above and occasionally feed on the young fruit. A few such fruits were tagged, but no mature apples were obtained showing scars caused by this species.

The clouded apple leaf bug
(*Neurocolpus nubilus* Say)

Another leaf bug which has been reported as feeding on apple in Canada, and which the writer found breeding on apple in Genesee County, is *Neurocolpus nubilus* Say. This species also was found to prefer the tender shoots on the apple tree, and in this case the bugs were not observed feeding on the fruit.

The rosy apple aphid
(*Aphis sorbi* Kaltenbach)

The rosy aphid, when present on the apple tree, makes its presence known just as soon as the young fruits are set, and immediately develops so rapidly and in such numbers that the young fruit stems and adjoining leaves soon become pink with the crowded aphids. By the time the young fruits are one-half inch in diameter, or by the end of June, this species of aphid migrates from the apple tree, but not before it has done considerable damage. The rosy aphid prefers to develop on the lower limbs and on the inside or shady parts of the tree, but in years when it is abundant and the season is favorable it may spread to all parts of the tree and do immense damage unless control measures are taken by spraying at the right time. The writer found this aphid present each season in limited areas, particularly on Rhode Island *Greening* trees and in orchards where the trees were crowded and not properly pruned.

Where the rosy aphid has developed and has sapped the stems of the young apples, the fruits never become thinned out during the June drop. All infested fruits remain on the tree, forming clusters where there should be only one apple growing. A typical group of young fruits just recently abandoned by the rosy aphid is shown in Plate IX, 29. The cast-off skins of the developing aphids are shown on the leaves, and each fruit that set following the bloom still clings and continues to develop very slowly in its gnarled and injured form. This species of aphid does not remain long on the fruit, for by June 25 the winged forms were rapidly developing and leaving the apple tree in favor of their alternate, or summer, host plant. It appears that the feeding aphids have a tendency to harden the stems of the young fruit, causing each one so affected to cling and produce the crowded and undersized condition of fruits so characteristic of trees where aphids have been at work. Few if any seeds are present in the apples thus affected, and all retain a gnarled and malformed shape, particularly a puckered appearance at the base and at the calyx end (Plate XI, 32). In Plate X, 30, is shown a cluster of six young apples, photographed on the tree on July 4, which were identical in appearance on June 24 to those in the cluster shown in Plate IX, 29. The same six fruits (Plate X, 30) are shown in their natural size at picking time (September 25) in Plate X, 31. The fruits still show the heavy coating of spray material to which the tree was subjected during the first week in August.

All varieties of apples are infested in years when the season is favorable to the increase of aphids, but of the standard varieties the Rhode Island *Greening* and the Baldwin apples are the most frequently affected. It was observed that Baldwin apples may be infested only very slightly by the

aphid, yet each apple will remain on the tree until picking time, being about one-third the normal size for that variety and showing the characteristic puckering effect at the calyx end. Systematic thinning of the young fruits helps somewhat to increase the size of apples thus affected, but still the result is far from satisfactory to the grower. The most distinctive malformation caused to the apple by the rosy aphid is the puckering at the calyx end, which is very often accompanied by puckering at the base also. In Plate XI, 32, are shown three pippin apples (September 9) which were puckered chiefly at the base, this probably being due to the fact that in this variety the young apples developed and increased in size so rapidly that the aphids did not work beyond the broad base as they do on the small fruits. Heavily infested fruits usually develop a characteristic ribbing and warting of the surface, a condition produced only by clusters of these small insects. The uneven surface and puckering of the fruit is due to the fact that where the cells are punctured by the sucking aphids, little growth takes place, while the surface between punctures tends to grow; hence the warting. Red Astrachan apples affected by the rosy aphid are stunted similarly to other varieties, and in addition they are found to ripen sooner than other fruits on the tree. A fruit cluster of this variety which was infested by aphids in June was found to be ripe and cracking open by July 13.

On May 28, 1915, a killing frost occurred in western New York, destroying all the fruit in many of the orchards. A curious phenomenon was noted in those orchards where the fruit was killed, namely, that the fruit clusters infested by the rosy aphid did not wither and fall as did all other fruits. The apples in the aphid-infested clusters were found to be without seeds and were very much stunted and malformed. These aphid-infested and frosted fruit clusters were found to cling to the tree throughout the summer and even until picking time.

The apple leaf aphid
(*Aphis pomi* De Geer)

The apple leaf aphid breeds on the tree throughout the season but becomes most abundant during July, the period immediately following the disappearance of the rosy aphid from the apple tree. The injuries it produces are usually made in a slightly different manner from those of the rosy aphid. *Aphis pomi* is always most abundant on the new succulent growth, and particularly on young trees that are growing rapidly. In years when the season is favorable for aphid development, even the large and well-pruned trees of standard varieties become seriously affected. The damage caused by this species is often not so much in stunting or

malforming the fruit as in the production in vast quantities of honeydew which covers the fruit. A black fungus soon develops on this honeydew excretion, covering the leaves and the fruit to such an extent that the latter is rendered unsalable from its appearance alone (Plate XI, 34). This aphid usually works only on the fruit stems and the leaves, checking the growth of the apples to such an extent that by picking time they are only half or one-third the size of normal fruit. But in years of greatest abundance the aphids may even cover the whole apple and produce the puckered fruit so characteristic of the work of *Aphis sorbi*. The fruit is usually an inch or more in diameter by the time the leaf aphids begin to cover the tree. By that time the June drop has caused a thinning of the fruit, and the apples that remain during July are expected to develop and reach maturity.

Because of its later development, this species does not normally produce the clustering of fruits to such an extent as is found in the case of *A. sorbi*. In Plate XI, 33, is shown a cluster of Baldwin apples which were infested by the rosy aphid until June 25 and then by *A. pomi*, which followed immediately and persisted until July 20. The puckering of the fruit was caused almost entirely by the rosy aphid, while the black and smutty appearance produced by honeydew and fungus is the natural result always following in the wake of *A. pomi*. Very frequently young and thrifty apple trees may produce fruit of normal size, yet the aphids developing almost exclusively on the leaves will excrete sufficient honeydew to cover the apples and make them unsalable from their appearance. One can invariably detect the work or the previous infestation of *A. pomi* from the fruits alone, since the black or smutty appearance caused by the fungus remains for a long time.

The San José scale

(*Aspidiotus perniciosus* Comstock)

At least four species of scale insects may occur on the apple in New York, but the one most frequently seen on the fruit is the San José, or pernicious, scale. If this scale is at all present on the tree, it is almost sure to make its appearance on the fruit before the apples reach maturity. One scale-infested orchard that the writer observed was always treated with the dormant lime-sulfur spray, but apparently there were always a few spots left untouched by the solution since the insects invariably developed on several trees and a certain percentage of the fruit always showed the scale spots. In the fruits observed and photographed, the young insects began settling on the apples during July. They were few in number at this time, but before the fruit was picked these first scales had matured

and had produced numerous young which covered the stem and calyx ends, and frequently the sides of the apple as well (Plate XII, 35 and 36). The lenticels in the skin of the apple show as minute white dots, while the young scales may invariably be distinguished by the appearance of a still smaller dark speck in the centers of the spots formed by them.

On badly infested trees the stem and calyx ends of the apples are usually found to be plastered with numerous small black scales which cover the half-grown insects and form a grayish, roughened, scurfy mass on the skin of the fruit (Plate XII, 35). The largest scales, covering the full-grown females, are nearly circular in outline, grayish in color, and about the size of a pinhead; while the smaller, half-grown scales are blackish, with a central gray dot surrounded by a black depressed ring which in turn is surrounded by a grayish ring. One can usually distinguish the San José scale from other closely related species by the form of the young scale, the raised cone point at the center of the scale, and the surrounding black depressed ring.

When infested apples mature on the tree, a red color develops around each scale or cluster of scales which gives a very characteristic and well-known scale-infested appearance to the fruit (Plate XII, 36). In a favorable season, such as 1914, when rains occur during August and produce a late scab-infection period, some of the early-maturing apples, particularly Maiden Blush, may develop a color about the tiny scab infections, producing an effect not greatly different from that of scale (Plate XII, 37). In the writer's experience a good many growers have noted this late scab infection with considerable concern, thinking it must be the San José scale. A person familiar with scale could scarcely make this mistake, however, since a close examination shows the absence of any scale and in its stead a tiny black spot surrounded by a pale, scurfy-like ring caused by the scab fungus forcing up the thin, transparent layers of epidermis, beyond which color may develop in the skin of the fruit. Late scab infection is shown in Plate XLII, 181, on a Rhode Island *Greening*, which is typical of the dark green varieties in that no color developed about the points of scab infection.

The oyster-shell scale

(*Lepidosaphes ulmi* Linnaeus)

Another scale which is frequently found on apple trees throughout New York State but is not of prime importance is the oyster-shell scale. This species may infest trees to such an extent that limbs may be killed, but since it has only one brood in New York there is scarcely any opportunity for the young to settle on the fruit. The tiny young scales are hatched

and complete their active period of moving over the tree before the apples set, and therefore in the northern localities there is little opportunity for infesting the fruit. Apples showing the oyster-shell scale developed on the fruit are on record, but these fruits evidently all came from more southern localities where two broods of this scale develop in one growing season.

The scurfy scale

(*Chionaspis furfura* Fitch)

The scurfy scale is recorded from several localities in New York, but the writer failed to find it infesting the apple in the western part of the State. Slingerland and Crosby record two broods of this scale at Ithaca, New York, and the writer has seen the scales on the fruit of pear from the same locality, which would indicate that two broods had developed. In localities where two generations develop, the second brood might be expected to produce some scale on the fruit in those orchards where it occurs on apple trees. This species of scale is easily distinguished by the broad, grayish white, pear-shaped female scales, with two minute cast skins clinging to the smaller end of the broad, thin, whitish part which forms the scale proper.

LEPIDOPTERA

In the Lepidoptera only the immature, or larval, stage of the insect is able to do damage to fruit. The adults have sucking mouth parts suited for taking up nectar or other substances in liquid form, and thus they rarely have opportunity to injure fruit. Ripe peaches are sometimes ruined in the Central States by depredations of the migrating cotton moths (*Alabama argillacea*), which sometimes congregate in large numbers to sip the sweet juice of ripened peaches. The writer has seen army-worm moths (*Cirphis unipuncta*) feed on the juices of very ripe Bough apples on the tree. But aside from such rare occurrences, it may be stated that the adult insects of this order do not cause injury to fruit. The lepidopterous larva is provided with mandibles by means of which it cuts and prepares its food for entry into the alimentary tract; therefore, although the adult is a sucking insect, the larval stage must be placed in a group commonly designated, for convenience, as having biting or chewing mouth parts.

Lepidopterous larvae may feed externally or internally on the apple. As representatives of internal feeders, the codling moth and the lesser apple worm furnish the most conspicuous examples. The internal feeding results in wounds that never heal perfectly, usually ending in brown rot, premature ripening, and falling of the fruit before picking time. Wounds

made by the external feeders — and these species are the most numerous — will often heal over, producing a characteristic scar, provided the injury occurs prior to mid-July while the apple is growing rapidly. Wounds produced later than the middle of July will invariably result in brown rot, for with the slowing-down in growth the healing powers of the fruit are not sufficient to overcome infections. Furthermore, the extent to which the fruit may be injured and still recover depends much on the number of apples on the tree, as well as on the rate of growth at the time of injury. These factors are dwelt upon more at length elsewhere in this paper.

The codling moth

(*Carpocapsa pomonella* Linnaeus)

The codling moth is the oldest, the most destructive, and probably the best-known pest on the fruit of the apple. The moderately large, pink-tinted larvae are only too frequently found boring through the flesh of the fruit and forcing out the brown frass from the exit of their burrows — a sight familiar to all who frequent orchards or eat newly ripened apples. There are, however, certain phases of codling-moth work which are not always recognized by the casual observer, and it is these obscure features that the writer has sought to present and illustrate herein.

As an aid to the understanding of injuries produced by the codling moth, a review of the life history for a typical growing season is presented as observed in western New York during 1914. The spring brood of moths began emerging on June 3, and came forth in greatest numbers between June 8 and June 14, or for a period of a week immediately following the closing of the calyx on the young apples. The eggs were probably laid in greatest numbers between June 10 and June 20, and the newly hatched larvae began entering the fruit about June 10 and were entering in maximum numbers up to the end of the month. From July 1 on, the larvae entered the fruit in gradually decreasing numbers through the period up to July 25. The last moth to emerge in the cages, from the larvae kept over winter, came forth on July 15, and in the orchard this moth might have been expected to lay eggs as late as July 25.

The first larva of the spring brood which was observed to have completed its growth did so by July 6, and others were found to be leaving the fruit on July 8 (Plate XII, 38). Several trees in an unsprayed orchard were stripped of the rough bark and then kept continuously banded with burlap. In this way most of the larvae that completed their growth and sought suitable places under the bark for spinning cocoons were always found in the burlap. Several such larvae were taken from the bands on July 11. These larvae spun cocoons immediately on enter-

ing the burlap bands, pupated within three days, and after a rest period of ten days began emerging as moths of the second brood. In the cages the first moth of the second brood came forth on July 24, but the majority of those that emerged appeared between July 28 and August 10. From these data it is apparent that the egg-laying period of the first-brood moths extends up to and may slightly overlap the appearance of the second-brood moths.

Larvae that had been collecting since August 3 were taken from the bands on August 8, and from this lot one or more moths emerged each day between August 15 and August 27. The larvae that entered the bands on the trees after August 8 did not transform, but remained in the larval stage until the following spring. The larvae produced by the late-emerging second-brood moths were always abundant in the unsprayed orchards during September, and a few were to be found attacking the fruit practically up to picking time. The line of demarcation between the two broods of larvae is not apparent from the work on the trees, since the work of the late first-brood larvae is similar to that of the "side-worm" injuries produced by the second brood. During the last ten days of July it was always possible to find a few tiny larvae just entering the fruit, and these could not be assigned with certainty to either brood. The last larva that the writer could assign definitely to the belated first-brood moths was found entering an injured Baldwin apple on July 20 (Plate XIV, 46), working its way in at the bottom of a scar produced by the fruit-tree leaf roller. Thus it is seen that the two broods of moths overlap in their period of activity and there is a time during which larvae from both broods are to be found entering the fruit.

From these observations and similar ones made during 1913, 1915, and 1916, it may be stated that in western New York the codling moth produces one full brood and a partial second brood, the size of the latter depending apparently on the character of the season. The method of attack by first-brood larvae is fairly well known, in that the majority of the young larvae enter the fruit by way of the calyx end. It is the habit of the larva to always seek some depression on the surface of the fruit; when the apple is small it is usually the calyx cup, but later, when the apple is large, the point of entry may be at any break or scar in the fruit skin or at a spot where a leaf rests closely against the apple. After feeding for a short time in the calyx cavity, which is its usual procedure in June, the young larva works its way to the center of the fruit, where it devours some of the seeds and the core tissue. After the fruit has attained considerable size, the newly hatched larva is as likely to enter on the side or the stem end as to find its way to the calyx cup. It rarely enters, however, on the smooth exposed surface of the apple, preferring

to work in at some slight depression, at a contact point between two apples, or where a leaf gives some protection from the sun. When nearly grown the larva invariably works its way to the surface of the fruit and begins forcing excrement from the burrow (Plate XIV, 43), and this frass, taken with the premature ripening of the fruit, is a certain indication that the codling-moth larva is at work. The exit hole is kept carefully closed with frass, probably as a protective measure against parasites and predacious enemies. But when growth is completed, the larva departs from the fruit, forcing out the frass plug. An open burrow is a sure indication that the larva has deserted the fruit and gone in search of a suitable place in which to spin a cocoon.

By the end of June and during the first week of July, when the apples are about one inch in diameter, the larger and more advanced of the first-brood larvae begin forcing out the characteristic brown frass from their burrows. The apple shown in section in Plate XII, 38, illustrates this very well, the larva being fully grown and practically ready to leave the fruit. The exit to the burrow is most frequently in close contact with a leaf or at a point where two apples rest in contact (Plate XIII, 40), and such a condition probably lends some protection to the larva against its parasitic enemies. The extent to which the codling-moth larva may burrow in the small fruits is shown in Plate XII, 38, photographed on July 8. Such apples invariably drop within a few days, but the larva leaves the fruit first unless a storm or an unusual wind intervenes. During the latter part of July, when the apples are much larger, the feeding larva gradually works its way to the core of the fruit, where it feeds on the seeds and the surrounding pulp. In Plate XII, 39, is illustrated the kind of cavity that the larva makes in a large apple. The two apples shown in Plate XIII, 40 (photographed on July 28) present the characteristic appearance that results when two or more larvae begin work where two apples rest in contact. The apples were spread apart for the photograph and the work of more than one larva may be detected. Probably three or four larvae started work between the two apples, and the two that survived until the photograph was taken had been at work perhaps not more than ten days.

The codling-moth larvae that enter the apple during the latter part of July and in August and September, most frequently enter at some scar, at some abrasion of the skin where two apples touch one against the other, or under a leaf that lies in close contact with the fruit. A high proportion of the larvae evidently do not succeed in entering far into the apple, but die from various causes soon after making a small opening through the skin of the fruit. The tiny newly hatched larvae probably seek the shaded and protected parts of the fruit for definite reasons. In fact, few

if any larvae ever succeed in entering on the side of the apple where the hot sunshine beats upon it. It is apparent that the young larvae are not able to withstand the excessive amount of sap that issues from a fresh wound. This is particularly noticeable if the sun shines hotly upon the fruit, for many larvae are found dead apparently from the effects of the hot sap that boils out. If the larva is successful in its efforts to enter the fruit, a white frothy spot covers the point of injury (Plate XIII, 41). This frothy spot gradually dries up and turns to white powder, soon to be followed by brown excretions from the larva. The larva remains near the surface for five or six days, gaining slightly in size and strength in order that it may be able to withstand the sap pressure which it must resist while working its way to the core. Having arrived at the core, the larva finds air space about the seeds and plenty of food; thereafter its chances of attaining maturity are very good.

On one occasion (September 12) a large apple was cut in section, and in the seed cavity was found a small white larva about one-third grown. A slender burrow indicated that the larva had worked its way in from the stem end of the apple. This particular larva was unusually white, with the head and the cervical shield black — effects possibly produced by an exclusive diet on seeds. The larva was so unusual in color that it was reared, in order to make sure that no other species was involved.

In Plate XIII, 41, is shown a pippin apple on which eleven young codling-moth larvae had tried to enter on the side of the fruit that was shaded by leaves. The tree had been sprayed on August 6, and apparently some of the larvae had died from the effects of the poison, for only five of them were found to be alive. The young larva will usually feed for two or three days at the surface, and because of this habit many larvae get spray poison but not before the skin of the fruit is punctured and a pinhole injury is produced. Large numbers of perfectly shaped apples must be discarded in the grading process due to the small pinhole injuries that result from the efforts of young larvae to enter the fruit, and, even though the larvae die in the attempt, the injury is not prevented (Plates XIII, 42, and XIV, 47). Slices with pinhole injuries, taken from apples that were sprayed for second-brood larvae, are shown in the latter figure. In case the larva was not killed, a white exudation persisted about the point of injury (Plate XIV, 47, a); while in case the larva died, the spot turned brown and dried up. The white deposit probably resulted from the evaporation of the excess fruit juice liberated by the young larva, rather than from any product of excretion. During August and September the apples that are exposed to sunshine will invariably develop color around the pinhole injuries (Plate XIII, 42), much as they do around scale insects. The color serves to enlarge the spot and make it more con-

spicuous. All such spots, in fact all pinhole injuries, soon become much enlarged, due to the development of brown rot. At picking time all but the more recent pinhole injuries appear as brown, sunken spots having a tiny hole at the center (Plate XIV, 47). When undisturbed by rubbing, the smallest and most recent pinholes will show the characteristic white powdery substance about the opening (Plates XIII, 42, c, and XIV, 47, a).

Rarely, if ever, do two codling-moth larvae come to maturity in the same apple; when more than one larva is present in a fruit they fight for possession, the conqueror usually devouring the vanquished. The Rhode Island *Greening* illustrated in Plate XIV, 43 (photographed on September 26), shows excessive tunneling for one larva. It has four exits to the surface, one on each side with the plug removed as if two larvae had departed from the fruit. In Plate XIV, 44, the same apple is shown in section, with all the tunnels more or less connected at the core but not like the common runway of a single larva. Brown rot, which invariably develops in the larval tunnels, is clearly shown surrounding the right-hand tunnel.

Various species of flies, particularly *Pollenia rudis* and several large species of muscids, are frequently found feeding and enlarging holes that were started by the young second-brood codling-moth larvae (Plate XIV, 45). The flies sip up the juices found in the brown-rot spots and thus enlarge the primary injury into a deep, rounded hole, in many cases cleaning out the brown rot down to the living tissue.

The lesser apple worm

(*Enarmonia prunivora* Walsh)

The lesser apple worm has frequently been confused with the codling moth, and is in fact closely related to that species but is much less abundant in New York. The full-grown larva is very similar to that of the codling moth, but is smaller and on close examination can be distinguished by the comblike structure on the caudal curvature of the anal plate. The work of the lesser apple worm during August and September can readily be distinguished from that of the codling moth by the nature of its burrows. In its early stages, at least, the larva remains near the surface of the fruit, eating out a blotched mine consisting of numerous tunnels just beneath the skin of the fruit (Plate XIV, 48). When half grown it may eat its way to the core, as shown in the section at the left of the figure. This section, taken from just beneath the typical surface mines, shows that the larva had made at least four tunnels to the core. The larvae of this species continue working on the apples until picking time, and any undetected larvae that have a start on the fruit may con-

tinue work even after the fruit has been placed in barrels. The work of the lesser apple worm is the most likely to be confused with that of the red-banded leaf roller (*Eulia velutinana*), described later; but in the case of the latter species, the skin of the fruit is eaten as well as the flesh underneath.

The fruit-tree leaf roller

(*Archips argyrospila* Walker)

The larvae of the fruit-tree leaf roller, when numerous on apple trees, may be very destructive to the fruit. The eggs of this species hatch at about the time when the fruit buds are swelling and separating slightly at the tips. The tiny larvae immediately bore into the fruit buds and begin their destructive work by destroying fruit clusters before the fruit is set. By the time the tree is in full bloom, the larvae have begun to spin silken threads, drawing together the blossom cluster with the new leaves into a loosely woven nest within which they feed. By the time the petals are falling, one larva will have destroyed a single fruit cluster; and as soon as the young apples begin to form, it will move to a new cluster, there to begin devouring the newly formed fruit (Plate XV, 49). As the apples grow larger, cavities are eaten into them by the larva, which remains close at hand in a rolled and webbed leaf that serves as a retreat (Plate XV, 50). One may frequently see a larva reaching out from its retreat and feeding at the base of an apple. This is a characteristic habit of the larvae after the apples have attained one-half inch or more in diameter. Usually the open end of the retreat is in close contact with the fruit, and so the feeding operations cannot be easily observed.

During the last ten days of June, after the apples have attained from one-half to three-fourths inch in diameter, the majority of the fruit-tree leaf-roller larvae complete their growth and change to pupae. Nearly all of the fruits injured by the larvae prior to June 20 drop as a result of the injury. Many of the apples fed upon after that date also drop, but the number of these is largely dependent on the abundance of fruit on the tree. As in the case of injuries by the apple redbugs, it is the weakest or the injured fruits that drop first; when there is a heavy set of fruit, the larvae may actually help thin the fruit, but when the set is light, many of the injured fruits will recover and grow to maturity, showing an ugly scar. The growing season of 1914 was normal and the set of fruit was heavy, and as a result the majority of injured fruits did not survive the June drop. An estimate for 1914, determined by counting the fruits tagged and by constant observation of the fruit injured after the apples had set, would place 95 per cent of the injured apples as dropping, and 5 per cent as recovering and growing to maturity showing a scar. In

orchards that were badly infested by the fruit-tree leaf roller, at least 10 per cent of all the apples that remained on the trees showed scars caused by this insect. Apples that grew to maturity showing a scar were those injured by late feeding of the larvae, for the most part after June 20. The tag experiments showed that all fruits injured prior to June 18 dropped, and only a few of those injured on June 18 and 19, which had the advantage of having all near-by fruits pruned away, were able to survive. The typical deep injuries made by the larvae after June 20 are shown in Plate XV, 51 and 52. These apples were picked and photographed on June 24. They would have recovered and grown to maturity showing typical scars, as did others similarly injured.

During early July, the apples that remain after being injured by the feeding larvae rapidly form a new surface over the wound; at first a brown, corky layer of dead cells covers the wound, but this soon cracks and falls away following the formation of new skin beneath. The mature scar has a bronze color and a slightly roughened surface. The character of the scar, as well as the ability to recover from the wound, varies according to the variety of apple affected. The power of recovery from wounds is particularly noticeable in the pippin and Twenty Ounce apples. Those apples that gain in size very rapidly may recover and grow to maturity even though the seeds have been eaten out. In Plate XV, 53, are shown three pippin apples, at picking time, which had been fed upon and had part of the core removed and yet grew to maturity. This may happen occasionally with a Rhode Island *Greening* or a Baldwin apple, but is rather unusual with these varieties. Typical leaf-roller work on Baldwin apples may be seen in Plate XVI, 57. In Plate XV, 54, is shown injury to Twenty Ounce apples (photographed on July 8) in which the feeding larvae reached the core on June 20; the smallest apple was ready to drop, but the others were recovering and would have attained maturity. On pippin and Twenty Ounce apples one may find unusually large scars made by the leaf-roller larva. Since these varieties grow very rapidly, the small feeding cavities made by the leaf roller will be expanded with the growth of the fruit until the scars are comparable in size to the work of green fruit worms on Baldwin and Northern Spy apples.

Very few leaf-roller larvae are to be found at work later than July 1, but the few that do work late produce some unusual scars which may prove difficult to identify. The scars that result from the work of larvae feeding as late as June 30 are unusually small and shallow. Such scars may sometimes be very similar to the shallow wounds produced by green fruit worms (*Xylina* spp.). However, the work of the fruit-tree leaf-roller larva can usually be recognized by the fact that some part of the scar will show a deep or a narrow excavation. Comparison between the

work of leaf-roller larvae and the work of fruit worms is shown in Plate XVI, 55 and 56, photographed nearly two weeks after the injury occurred. The broad, shallow work of the fruit worms is readily distinguished from the deeply excavated or narrow channels produced by the leaf-roller larvae. The work of the leaf roller shown in Plate XVI, 55, was selected as a sample of some shallow excavations, which is not the usual or typical work of the species and yet can be recognized as different from the broad, shallow work of fruit worms. Unusual types of scars caused by the leaf roller are shown in Plate XVI, 58 and 59. In rare cases the larva may move to a new apple only two or three days before it is ready to pupate, or it may be forced to abandon an apple prematurely, and in such cases typical scars would not result (Plate XVI, 59). The deep excavation in the Twenty Ounce apple shown in Plate XVI, 58, has been filled out by growth and to some extent produced a warted surface. Scars of all types may show accelerated growth if the conditions are right to force growth late in the summer, after the skin of the fruit has hardened.

The work of aphids on the fruit always has a tendency to stunt growth and harden the stems in such a way that injured or weak fruits are made to cling for a much longer time than they otherwise would. In one case observed, two apples were severely injured by a leaf-roller larva about June 15, but the apples were made to cling until July 8 (when they were picked), due to an infestation by the rosy aphid, which developed on the fruit cluster about the time when the injury was produced.

The problem of determining scars may frequently be made difficult by the work of two or more species occurring on one fruit. But after sufficient experience in observing typical scars for each species concerned, one may hope to determine accurately 98 per cent of all the scars found.

The oblique-banded leaf roller
(*Archips rosaceana* Harris)

The oblique-banded leaf roller occurs along with *Archips argyrospila* in the orchards of western New York, but is not nearly so abundant. In certain orchards one-tenth of all the leaf-roller larvae examined were found to be this species. The work of *Archips rosaceana* on the fruit does not appear to differ from that of *A. argyrospila.* In the field, while the larvae are actively at work, one may distinguish *A. rosaceana* by its yellowish brown to pale apple-green color and its brownish black head and thoracic shield, as contrasted with the invariably black thoracic shield and apple-green color of *A. argyrospila.* When determining the mature scars on apples as the work of leaf-roller larvae (*Archips* spp.), one is bound to include some work produced by *A. rosaceana* but the percentage will

be small. A second brood of the *A. rosaccana* larvae appears on the tender foliage of the trees in July and August, but were not found by the writer to infest the fruit.

The green fruit worm

(*Xylina antennata* Walker)

In western New York the commonest species of green fruit worm attacking the apple is *Xylina antennata*. The over-wintering moths come forth to lay eggs on the apple twigs before the buds have turned green. The eggs hatch during the first warm days, and the tiny larvae begin feeding on the tender leaves as soon as the buds begin unfolding. By the time the fruit is formed, the larvae are half grown, and, having a voracious appetite, are capable of devouring the young apples rapidly. The larva of this species is usually distinguished by the green color, the broad white lateral line, and the numerous small pale spots on the latero-dorsal surface. In 1914, which may be considered as a normal season, some of the larvae had completed their growth by June 15, or before the apples were one-half inch in diameter; others were more retarded in their development and did not finish feeding before June 20, and a few even later. The larvae that fed on the fruit on June 18 and later, were the ones producing the scars that showed on the apples at picking time.

The fruit worm is large when the apples set, and consequently the effect of its feeding is to cause the fruit to drop. When the apples are small, many of them are completely eaten. Only after they are one-half inch in diameter, and when growth is rapid, are they able to recover. A comparison is shown in Plate XVII, 60, between a fresh half-eaten apple injured by the green fruit worm, and an apple showing the deeply excavated and smaller scar produced by the larva of the fruit-tree leaf roller. This difference in scars is nearly always apparent, particularly in freshly injured apples, in which the broad, coarse, mandible marks of the fruit worm may be distinguished. A nearly full-grown larva of *Xylina antennata* is shown in Plate XVII, 61, excavating a deep, narrow wound to the core of an apple, but this manner of feeding is unusual. In a few cases a fruit-worm larva was found entirely inside an apple, having eaten out the core and enough of the pulp to form a retreat within. As a rule the larvae are intermittent and restless in their habits, feeding on one apple for a short time and then moving to another. This habit makes the fruit worm much more destructive than it would be otherwise, for the apples that are only slightly injured are likely to recover and grow to maturity showing a scar. The small scars made by a larva about June 10, when it was only about one-third grown, are shown in Plate XVII, 64. The

injury was so slight that the apples were recovering and the scars had healed over by June 24, when the photograph was made. One larva often feeds on a dozen or more fruits, or on all the apples on one small limb. The way in which one larva may feed on several fruits is well illustrated in Plate XVII, 65, showing how several pears on one limb were fed upon by a single larva but all recovered and bore ugly scars.

The broad scars produced by fruit worms on or before June 18 are usually so severe that the apples rarely recover, and yet in a few cases, where the set of fruit is light and growth is forced by warm rains, the fruits may grow to maturity. Scars made on June 20 are shown in Plate XVII, 62, as they appeared on June 24; the scars have turned brown, which is the first stage in the healing process. In Plate XVII, 63, are shown two apples that were injured on June 18; on June 24, when the photograph was made, the scars were rapidly healing, as is indicated by a few cracks in the brown corky layer composed of cells that died from the injury. A Rhode Island *Greening* apple which was injured on June 18 by the intermittent feeding of a green fruit worm is shown in Plate XVIII, 66, as it appeared on August 14. The broad, shallow scars are characteristic of fruit-worm injury but may sometimes be confused with the work of the white-marked tussock moth, discussed later. In one experiment a green fruit-worm larva was observed to feed on six apples from June 18 to June 20 inclusive, and during this time each apple received one or more feeding scars. This experiment was typical of the intermittent feeding in which several apples are only slightly injured, the scars being shallow and not very broad.

A comparative study of the scars made by green fruit worms on different varieties of apples shows some of the same differences developing that were noted in studies of the fruit-tree leaf roller and the apple redbugs. Twenty Ounce apples and pippin varieties were found to recover when severely injured, in many cases even after the core had been partly eaten. A most unusual recovery after injury by a green fruit worm was shown by a pippin apple (Plate XVIII, 67) in which the core and half of one side were eaten away, and in addition the larva devoured a part of the opposite side. The same apple if turned slightly would show how the scar extends to the center of the core, the new tissue folding inward over the cavity during subsequent growth. An unusual recovery for a Baldwin apple is shown in Plate XVIII, 68; a fruit worm ate part of the core on June 25, but the apple recovered and grew to maturity. For fruit-worm work this scar is rather small and deep, and might be confused with certain scars produced by the fruit-tree leaf roller.

The usual kind of scars produced by the green fruit worm and found on the fruit at picking time, is shown in Plate XVIII, 69 and 70; scars

appearing in the form of large wounds, more or less shallow, perfectly healed, bronze in color, and usually with bits of dried corklike tissue still clinging in places. Apples so injured keep perfectly in storage, but the disfiguration is taken as sufficient reason for discarding them in the grading process. Baldwin apples with typical scars are shown in Plate XVIII, 70. A scar on a Tompkins King apple which in outline is somewhat suggestive of the injury produced by the white-marked tussock moth, is shown in Plate XVIII, 69; but the old and dried-out corky tissue clinging to the scar indicates a period of healing prior to the time when the tussock-moth larvae begin their work.

The green fruit worm

(*Xylina laticinerea* Grote)

Another green fruit worm, which is second in abundance in western New York, is *Xylina laticinerea*. The larva of this species is distinguished from *X. antennata* by having a more slender white lateral line, and a median dorsal line equally distinct. The habits of both species are very similar and no distinction can be drawn between the injuries they produce. A larva of *X. laticinerea*, nearly full-grown, is shown in Plate XIX, 71, with four young apples on which it was feeding on June 18. The broad, rough scars produced by fruit worms are well shown in this photograph.

The red fruit worm

(*Rhynchagrotis placida* Grote)

A species conspicuous because of the red color of the larva, and occasionally found feeding on the apple in western New York, is *Rhynchagrotis placida* Grote. The larval habits of this species are slightly different from those of *Xylina* spp. *Rhynchagrotis placida* has been classed as a climbing cutworm, and such larvae are supposed to climb up the trees only at night for feeding. The writer occasionally found larvae of this species resting during the day, if not feeding, within the cavities they had eaten into the apple. When disturbed they curl up, as is the habit of certain cutworms, and in this respect they differ from species of Xylina. The larvae of *R. placida* are rather sluggish and do not move from one apple to another as freely as do the green fruit worms. Because of this habit, the apple fed upon usually shows two or three irregular scars. A Rhode Island *Greening* apple which was fed upon by one larva from June 16 to June 19 is shown in Plate XIX, 72; the photograph was made on August 16, and shows several irregular scars that resulted from the work of the larva. A Baldwin apple with a large, irregular scar is shown at maturity in Plate

XIX, 73. In each case the scars are large and very irregular, deep in some places and shallow in other parts — characters that may often enable one to recognize the work of this species. The age of the healed surface, being similar to that in the case of injuries produced by green fruit worms, will serve to distinguish the scars from those made by the tussock moth at a later date.

The white-marked tussock moth

(*Hemerocampa leucostigma* Smith and Abbot)

The white-marked tussock moth was found very abundant in a few apple orchards in Genesee County, New York, and became very destructive to the fruit. The egg masses, which remain on the trunk or the large limbs of the trees all winter, do not hatch until after the trees bloom and the fruit has set. The young larvae are not large enough to attract attention or feed on the fruit until about June 20, but, having started, they keep up their destructive feeding until after the June drop occurs, some larvae feeding as late as July 12. Consequently the injuries they produce are more likely to be in evidence as scars on the mature apples, since the fruits in most cases are large and are able to withstand the shallow feeding which occurs after June 25.

The larvae of the tussock moth normally feed on the tender foliage of several varieties of trees, but when they occur on apple trees they show a decided preference for the young, green apples. In observations on the feeding habits of the larvae it was noted that the early feeding (June 22) had a fatal effect on certain of the injured apples. The injured fruits were given such a setback in the struggle for sap and existence that the uninjured members of the fruit cluster outstripped the injured, with the result that many succumbed in the June drop which followed. Two larvae scarcely half-grown, feeding on the fruit on June 24, are shown in Plate XIX, 74. The larvae are restless in their habits, feeding for a short time in one spot and then moving to a new place. This habit, combined with shallow feeding, produces several scars on the same apple — a condition that enables one to recognize a high proportion of the scars produced by this pest. Two young Baldwin apples, photographed on July 4 (Plate XX, 76), show characteristic scars produced by the intermittent feeding of the half-grown larvae. As the apples get larger, one larva often remains feeding on the same fruit for five or six days (Plate XX, 75). The first scars produced begin healing while the larva still feeds on other parts of the same fruit. Some larvae may continue feeding on the fruit as late as the middle of July, but after the apples have grown larger and the skin has become tough the larvae are more likely to move to the tender new leaves to complete their growth.

After the middle of July the apples grow more slowly, and, as a result, injuries produced later than July 12 heal but very slowly and imperfectly. In fact, some of the tussock-moth larvae feed on the fruit until it is unable to replace the injury with new skin. Two Northern Spy apples photographed on July 20 (Plate XX, 79) show the long, shallow channels which the larvae make after the skin has hardened and is no longer tender to their liking. These fruits were injured between July 12 and July 15, the injured part drying out and shriveling slightly — the first indication of improper healing. A Rhode Island *Greening* apple photographed at picking time is shown in Plate XXI, 81; the scar is rough and hard, not having the smooth skin beneath as is found on scars that heal while the fruit is growing rapidly. Excessive late feeding by the tussock moth on a Rhode Island *Greening*, is shown in Plate XXI, 82, the injuries having been made so late that brown rot would have developed had the apple been an early-maturing variety. A Twenty Ounce apple which was fed upon by a tussock-moth larva after the middle of July (Plate XX, 80) shows how brown rot may start in any wound that occurs after the fruit has stopped active growth.

The mature scars produced on apples by the tussock-moth may present curious shapes and forms. The scars may be recognized, however, by the following combination of characters: (1) scars always shallow, frequently imperfectly healed; (2) scars irregular in outline, exhibiting slender feeding tracts; (3) several small, perfectly healed, irregular scars on one apple, or one or more large, rough scars having narrow, irregular tracts at some points on the margin. The work of the larva during the last week in June is characterized by intermittent feeding, the larva starting a new feeding place at any point where it may happen to be when hungry. Such scars heal with a smooth surface, since the apple is growing rapidly. Later, when the skin of the apple has begun to get tough, the larva does not like to make a new puncture, but wanders around until it finds the previous point of feeding, there to enlarge the wound or to extend it in narrow channels as it feeds. On one Rhode Island *Greening* apple observed, ten small surface scars were counted, all made by one tussock-moth larva; some of the scars were so small that they strongly suggested the work of the pistol case-bearer. Three larger and more irregular scars are shown in Plate XX, 77. A large, sinuate scar, typical of the tussock-moth work, is shown on a Rhode Island *Greening* apple in Plate XX, 78. This injury was produced near the end of the period when perfect healing would take place, and consequently the skin of the apple was then becoming so tough that the larva preferred to feed by enlarging one spot rather than making new ones.

Warting of scars was found to take place on tussock-moth injuries, as noted in the case of other scars, whenever the conditions were right to produce such effects. A large mature scar on a Jonathan apple is shown in Plate XXI, 83, in which the scar tissue has bulged out above the general surface due to new and unusual growth just beneath the scar. Such warting is caused by accelerated growth after the skin of the apple has become hardened; the scar tissue, being formed later than the skin on the other part of the apple, gives way at the point of least resistance under the pressure caused by new growth. In Plate XXI, 84, a small scar caused by the tussock moth is shown in comparison with an old scab spot, which also shows the effect of warting under pressure by growth late in the season.

The palmer worm

(*Ypsolophus ligulellus* Hübner)

In some years the palmer worm is very destructive to apples, but thus far such years have been few and far between. The species is known to have been very destructive in New York in 1853, and not again until 1900. It is evidently always present in apple orchards but in very limited numbers. During the years from 1913 to 1916, inclusive, while the writer was constantly inspecting orchards in western New York, he found palmer worms in only a few orchards and usually as isolated specimens. The larvae were found in greatest numbers in two orchards which had suffered from neglect.

Although material for study was scarce, observations were made and photographs were obtained showing the character of the wounds produced by the palmer worm. No larvae were observed feeding on the fruit before the middle of June, but larvae found after that date were always working on the fruit. A typical example of the injuries produced during the latter part of June is shown in Plate XXI, 85, taken on June 25. The small, slender larvae, marked with pale longitudinal lines and with two broad dark stripes, move with a wriggling motion when disturbed, frequently abandoning the web-covered retreat on the fruit and dropping below on a silken thread. After feeding for three or four days on one apple, the larva invariably secretes itself under a web spun over the cavity which it has eaten into the fruit. Bits of web remain in the wound long after the injury is made (Plate XXII, 86), serving to identify the pest that did the damage. In Plate XXII, 88, is shown an apple, photographed on August 12, in which the larval web may still be seen in the scar.

All fruits injured before June 20 were found to drop, and only the late-scarred fruit, injured after that date, remained on the tree to develop

mature scars. The late work is characterized by deep and narrow scars (Plate XXII, 87). In certain cases in which the web spun by the larva is not visible, the work of this species might be confused with the late work produced by the fruit-tree leaf roller. In the case of a Roxbury apple photographed on July 21 (Plate XXII, 87), there are to be seen five small holes grouped closely together, the work of a larva during the last three days of June; but the bits of web found still clinging to the wound would serve to identify it as the work of a palmer worm.

The bud moth

(*Tmetocera ocellana* Schiffermüller)

The bud moth is well known as a pest chiefly because of the damage which the larvae may do by eating into the young fruit buds during May, thus destroying the crop before the fruit is formed. When abundant, this insect may also do considerable damage to the maturing fruit, and, for the present study, observations are recorded on this phase of the insect's activity.

The larvae that destroy the buds in spring, change to pupae during June. After ten days in the pupal stage, or during the last few days in June and the first two weeks of July, the moths come forth to lay their eggs on the leaves. In the latter part of July, the tiny, black-headed caterpillars hatch from the eggs and begin to feed on the under side of the apple leaves. All during September the small, reddish brown larvae may be found feeding on the under side of the leaves, usually hiding beneath a protective layer of web, this being constantly rebuilt to cover new feeding areas. When a leaf bearing a larva comes in contact with an apple, the leaf is frequently drawn against the fruit and firmly attached to it with web. Within this safe retreat the larva continues to devour parts of the leaf, and in addition it may eat several small round holes through the skin of the apple. The first work of this kind on fruit was found on August 8 (Plate XXII, 90), the larva having fed extensively on the leaf but having made only four or five holes through the skin of the fruit when disturbed. The same type of work is better shown on a Pound Sweet from which the leaf was turned back and photographed on September 15 (Plate XXII, 89). Even in well-sprayed orchards, many apples will be found that appear to be perfect and yet when they are picked a leaf is found sticking to one side, beneath which the work of the bud moth is revealed.

The work of bud-moth larvae on the maturing fruit may invariably be distinguished by a group of small holes eaten through the skin, while

the light area about the injury indicates that a leaf has been held in contact with the spot sufficiently long to make an appreciable difference in color. In case the injury has not been rubbed, bits of web and a white powder may be found about the scars. Although the wounds made in the fruit by the bud moth during September are small, when careful grading of the fruit is done or apples are selected for show purposes many perfectly shaped apples will need to be cast aside or relegated to the inferior classes due to these small feeding punctures.

The red-banded leaf roller

(*Eulia velutinana* Walker)

An insect that was doing a slight amount of damage to the fruit during August and September proved to be *Eulia velutinana* Walker, a species not ordinarily recognized as a pest on the apple. On July 28 the writer first noticed a larva of this species which was feeding in an unusual manner between two Genesee Flower apples (Plate XXIII, 91). This larva, with the apples, was placed in a breeding jar, where it pupated within a curled leaf on August 2. When full-grown the larva is very suggestive of *Archips argyrospila,* but is slightly smaller than that species. From the pupa developed on August 2, a moth emerged on August 11. The moth of this species has a tuft of hairlike scales on top of the thorax, is slightly smaller than that of *Archips argyrospila*, and has much less of the dark brown color. The spread moth is shown, somewhat enlarged, in Plate XXIII, 92.

The work of *Eulia velutinana* was frequently found on the fruit during August and September, and a few larvae were still at work when the fruit was picked. The larva is a surface feeder, evidently never eating deeply into the fruit as is done by the fruit-tree leaf roller. A typical example of the work found during August may be seen in Plate XXIII, 93. The larva prefers to live and feed on the fruit while secreting itself beneath a leaf or by working between two apples that rest in contact. Sometimes a detached leaf is fastened to the fruit with web, and this serves as a retreat or protection from which the larva can feed. Late in the season a decided preference is shown by the larvae for eating only the skin of the fruit (Plate XXIII, 94). A Baldwin apple which had been kept in a barrel for two months was found to have on November 29 fresh shallow scars, such as the late-feeding larva will produce, and attached to the fruit was some web in which the larva had secreted itself.

The work of *Eulia velutinana* during August and September may be distinguished by the broad and shallow feeding scars, which never heal

due to the lateness of the season. No other species was found to be doing a type of work that could be confused with the scars here illustrated. The damage to fruit caused by this species is doubtless done by larvae of a second brood, though the complete life cycle is not known.

The pistol case-bearer

(*Coleophora malivorella* Riley)

Case-bearers are interesting little insects, for the larvae of each species live within and carry about with them a case of a particular pattern composed of leaf fragments. The pistol case-bearer always constructs a case which in form resembles a pistol case. In western New York the pistol case-bearer was frequently found infesting apple trees, and particularly those orchards that had not received a thorough spraying just before the flower buds opened. The young larvae hibernate in tiny cases attached to the twigs of the tree, and as soon as the buds show green they move from winter quarters and cluster on the unfolding tender leaves.

As soon as the fruit sets, many of the larvae find their way to the young apples and begin feeding. The case-bearer larva feeds by making a round, deep hole through the skin of the fruit, and then mining out the parenchyma in all directions as far as it can reach without entirely deserting its case. Having obtained all the food possible at one point, the larva creeps along with its case to a new location, settles down, eats through the skin, and begins feeding as before. Pistol case-bearers, nearly mature, are shown in Plate XXIV, 95, at work on young apples on June 9; the small, round, black holes show points of previous feeding. One case-bearer may make several such feeding punctures on one or more apples.

The larval activity of a single case-bearer is well shown in Plate XXIV, 97. This larva began feeding on a Twenty Ounce apple, a variety that grows so rapidly and attains such size that the case-bearer is unable to kill the fruit. The regular progression in size of scars is due entirely to the effect of growth, the largest scars being those first produced while the smallest scars are those made by the larva's feeding after the apple had attained considerable size and when little expansion was possible by further growth. The clear spots in the leaf show the effect of larval feeding on the foliage. On completing its growth the case-bearer moved from the fruit to the adjoining leaf, and then to the twig, where a firm attachment was made preparatory to pupation. The moth emerged toward the end of June, but the case remained in position for a long time after. The photograph was made on August 30, after the apple had attained more than half its growth and was apparently stunted somewhat by the injuries received.

The mature scars frequently show a funnel-shaped depression at the center, indicating that the cavity produced by the larva is not always entirely filled out by growth (Plate XXIV, 96). This feature, combined with the numerous small, rounded scars on a single fruit, is characteristic of case-bearer work. The large scars that sometimes result from the very early feeding of the case-bearer larva might be mistaken for the rounded scars made by the tussock moth, were there not a gradation in size of the scars.

In a few instances the scars made by this case-bearer were found to produce a splitting of the skin about the wound, very similar to the way in which splitting and enlargement of the scar occur with redbug injuries. A good example of this is shown on a Detroit Red (Plate XXV, 98), in which the contrast between the bronze scar tissue and the red skin of the apple is conspicuous.

Several types of mature scars from Baldwin and Twenty Ounce apples are shown in Plate XXV, 100, slices from different apples being arranged in a group for purposes of comparison. The work of the case-bearer on a crab apple as illustrated in Plate XXV, 99, shows all types of scars and particularly the effect of warting. The skin of the crab apple hardens early in the summer while growth pressure is still being exerted; hence the more recent and tender scar tissue gives way to the new cell formation underneath.

The cigar case-bearer

(*Coleophora fletcherella* Fernald)

The second species of case-bearer frequently found in abundance in apple orchards is easily distinguished from the preceding species by the shape of the larval case. This insect has received the name *cigar case-bearer*. The life history of the species is very similar to that of the pistol case-bearer, and the injuries it produces cannot with any degree of certainty be distinguished from those of that species.

The cigar case-bearer, and its work on young apples just formed, are seen in Plate XXV, 101, an enlarged photograph showing well the character of the feeding punctures and likewise the shape of the larval cases.

In this study of the identification of mature scars it was found that the work of *Coleophora fletcherella* could not be distinguished at picking time from that of *C. malivorella*, and for economic purposes the injuries by both species may well be classed simply as case-bearer work.

The work of case-bearers on apples may usually be distinguished as follows: (1) by several small, rounded scars of different sizes appearing on one apple; (2) by some of the scars showing a funnel-shaped depres-

sion at the center; (3) in rare instances, when the wound has split and caused an irregular margin, by the distinctiveness of the funnel-shaped depression.

The fall webworm

(*Hyphantria textor* Harris)

The fall webworm is a well-known pest on forest and shade trees and at times may become abundant in apple orchards. The larvae begin making their unsightly webs on the branches of the trees during July, but these are more noticeable during August. The larvae of the fall webworm are essentially leaf feeders, but when they occur on apple trees their web nests frequently inclose a few apples. The larvae do not appear to prefer the fruit, but when apples come within their range they feed upon them. When abundant in an apple orchard the webworms may cause more or less damage to the fruit, not only by direct feeding on the apples but also by defoliation of the limbs, thus causing a stunting and shriveling of the fruit.

The work of fall webworms on two Alexander apples is shown in Plate XXVI, 104. All the leaves on the limb are brown and the fruits are covered with web and excrement. The larvae make broad, shallow feeding tracts over the surface of the fruit, but in places they feed more deeply. Two larvae may be seen in Plate XXVI, 102, feeding in cavities formed on an Alexander apple. The feeding always occurs so late in the season that healing of the wound never takes place. The scar surface usually shrivels and dries out considerably (Plate XXVI, 103). Unless the injured fruits have been purposely cleaned, the work of the webworm can always be recognized by the presence of web and excrement on broad, irregular, shallow scars which never heal.

The apple serpentine miner

(*Marmara pomonella* Busck)

An insect very interesting because of the peculiar habit of the larvae in making serpentine mines in the skin of the fruit, proved on determination to be *Marmara pomonella* Busck. This species was found working on the fruit from two localities in New York, but as yet it cannot be reckoned as a pest of economic importance. Two types of the serpentine mine made by the larva on Baldwin apples are well shown in Plate XXVII, 105 and 106. In one of these (106) the larva projected its mine in a circular course, causing a large blotch on one side of the apple; in the other, the larval mine proceeds in sinuous fashion all the way around the fruit. The larva works only between the epidermal and cuticular layers of the apple

skin, thus never causing injury to the flesh of the fruit. The damage, if such it can be called, is merely a matter of disfigurement of the apple. The serpentine mines are made during the latter part of the summer, after the apple has attained considerable size, and thus there is little opportunity for the insect to deform the fruit.

COLEOPTERA

The coleopterous pests on the fruit of the apple are few in number, and, excluding the work of a few occasional infestations by species that are general feeders, it may be said that only two species, both belonging to the Rhynchophora, are found to feed and develop larval stages in the fruit.

The plum curculio

(*Conotrachelus nenuphar* Herbst)

The plum curculio is known chiefly as a pest on plums and other stone fruits, but when these fruits are not available it may cause serious damage to apples. In one season the species may breed in large numbers on stone fruits, and in the following year, if there is shortage of plums and cherries, the beetles will migrate to the nearest apple orchard, there to begin their work on apples.

The plum curculio hibernates as an adult and comes forth in spring to the fruit trees, where it takes its first meal, and feeds until such time as young fruits are available on the tender, succulent growth. As soon as the apples set, the curculios begin feeding on them with ravenous appetite, and particularly is this true of the females, which are preparing to lay eggs. The early feeding punctures are in the shape of round holes in the skin of the fruit, through which the curculio excavates all the tender pulp that it can reach by inserting its long rostrum. In Plate XXVII, 107, is shown, slightly enlarged, a curculio resting on a young apple beside a typical feeding puncture that it has just completed. All the fruits injured in this manner were found to drop; since the fruit is so small and competition is great, few apples ever survive when injured at such a tender age.

After feeding for a few days, the female curculio is ready to begin laying eggs, and this is about the time when the apples are one-fourth of an inch or more in diameter (Plate XXVII, 108). The ovipositing female makes a small hole in the fruit just large enough to receive the egg, then deposits it and cuts a crescent-shaped slit extending in a semicircle around and obliquely beneath it. Such an arrangement doubtless prevents the egg from being crushed by growth pressure, and especially

protects the young larva at the time of hatching. Young fruits having egg crescents, and one with a feeding puncture, are shown for comparison in Plate XXVII, 109. Young apples in which curculio eggs have been deposited will fall to the ground, and if undisturbed the larva will develop to maturity. In fact, it seems to be necessary for the apple containing the eggs to fall to the ground if the curculio grub is to develop. Rarely are apples containing living larvae found on the tree, except late in summer when active growth has stopped, and such fruits would fall in any case before the larva had worked very far. It is apparent that a softening or shriveling of the fruit must occur before the grub is able to make much progress. Evidently vigorous growth and strong sap pressure in the fruit are more of a barrier to the curculio grub than to codling-moth larvae. The only apple containing an active burrowing grub that the writer has found on a tree, was found on July 13 on an unnamed variety (Plate XXVIII, 112). This fruit was not in an active state of growth, and probably would have dropped to the ground before the grub reached maturity. Perhaps the lack of sap pressure in the fruit, which permitted the curculio grub to start its burrow, was due to causes other than larval activity of the curculio. Certain it is that, in the majority of cases, the apple must be one that will drop to the ground from causes other than the presence of the curculio grub, or else the grub will never have an opportunity to develop.

The injuries caused by the curculio early in the season serve to thin out the fruit, but after the young apples have attained one-half inch or more in diameter many of them do not succumb to the influence of one or more egg punctures. Such fruits grow to maturity exhibiting scars, frequently being more or less deformed. Three young Baldwin apples with curculio scars which may or may not prove fatal to the development of the fruit, are shown in Plate XXVIII, 111. After June 20 a majority of the apples having egg punctures do not fall to the ground because of curculio injury, but recover and develop scars. On two of the fruits shown in Plate XXVIII, 111, a white exudation may be seen on the crescent flap, indicating that the larva has hatched and is making some effort to feed. Rarely does one find curculios that have come out of hibernation making simple feeding punctures after the middle of June, since in excavating each egg crescent a certain amount of pulp is eaten. In Plate XXVII, 110, a beetle is seen excavating a typical round feeding cavity, a result obtained by keeping the curculio in a jar where it could not feed for three or four days. The male curculio might be expected to make feeding punctures which would result in a scar slightly different from the well-known crescent of the egg-laying female. The males, however, apparently

feed so seldom following the first great feast, when the young fruits set, that rarely, if ever, can scars be found that would appear to have developed from plain feeding punctures.

In an experiment to get data on the feeding habits of the adults, a curculio was caged with a single apple from June 29 to July 6. The apple succumbed to the injuries and fell on July 20, with the result shown in Plate XXVIII, 113, photographed on July 21. Normally the apples that have received only a few egg punctures by the end of June or early July will recover and grow to maturity.

Many of the wounds made by the curculio on Roxbury apples during July were found to develop brown rot, as is shown in Plate XXIX, 116. Several of the punctures appear as rounded cavities, and probably represent the feeding work of newly emerged adults in the latter part of July.

The well-known crescent-shaped scars (Plate XXIX, 117) resulting from the work of the ovipositing female during the latter part of June are generally recognized at picking time. The typical crescent has one straight side, at the middle of which there is a projecting point representing the place where an egg was inserted. In many cases this distinctive egg mark does not show plainly, but an interruption of the straight margin at the middle can usually be distinguished.

Mature scars from six varieties of apples are shown in Plate XXIX, 117, in which the egg-puncture marks are seen in varying degrees of distinctness, these apples representing skins of different colors and textures. The Twenty Ounce apple shown in Plate XXVIII, 114, indicates how several curculio crescents grouped together may resemble the scars made by case-bearers, but an examination of the individual scars shows clearly the distinctive egg-puncture marks made by the female when ovipositing.

Perhaps the scars sometimes made by apple redbugs are the most likely to be confused with curculio work. An apple having scars of both curculio and redbugs is shown in Plate XXVIII, 115, for comparison. As pointed out above, however, there is little danger of confusing curculio feeding punctures with redbug work, for the distinctive egg crescents are invariably present on apples deformed by the curculio.

A study of the late summer scars made by the curculio revealed the fact that brown rot often results in the wounds. As was shown in the case of late codling-moth work, certain large species of muscid flies may enlarge the scars and assist in the development of brown rot, and this the flies clean out as fast as decay takes place (Plate XXX, 120 and 121). When undisturbed by flies the feeding punctures made by the curculio during August will develop brown rot, this producing a dark ring about the point of injury (Plate XXIX, 116).

Frequently one finds that tough-skinned varieties, such as Ben Davis and Jonathan, when grown under the right conditions will exhibit warting of the curculio scars (Plate XXIX, 119). Here again the scars can usually be identified by the presence of the distinctive egg-puncture marks.

The apple curculio
(*Anthonomus quadrigibbus* Say)

The common name of *Anthonomus quadrigibbus* would imply that it is primarily the curculio pest of the apple. It is not, however, as serious a pest on apples in New York as is the plum curculio. In certain localities *A. quadrigibbus* breeds abundantly on wild haws (*Crataegus* spp.), but in only a few instances was it discovered working on fruit in cultivated orchards. The apple curculio may be distinguished from the plum curculio by its long, curved rostrum, its elytra, broader toward the rear, and its four prominent humps (Plate XXX, 122).

The apple curculio was found to be so scarce in orchards of western New York, that in order to study the injuries of this species on standard varieties of apples the writer collected a large number of the adults from hawthorn, and these were placed in cages with apples for experimental purposes. Forty pairs of the beetles were placed in as many tarlatan cages, each inclosing two or more young apples. Many of the young fruits were stung to death, but after June 15 many apples would cling when stung only two or three times. In order to prevent the fruits from being injured excessively, the cages, with the beetles, were moved to new fruits every two or three days. Several curculios continued to feed and lay eggs on the fruit until the middle of July, but after that date the beetles died off rapidly.

As soon as the curculios were placed with the fruit they began feeding and laying eggs with unperturbed activity. In Plate XXX, 123 (photographed on May 28) are shown two female curculios on a young apple, in which one of them is laying an egg. After depositing the egg the female turned about, closed the opening to the cavity with her rostrum, and then moved to the tops of the stamens to have a look at the surroundings (Plate XXX, 124). The opening to both feeding and egg cavities appears merely as a rounded hole in the surface of the fruit. Through this opening the curculio thrusts its rostrum in order to excavate and eat the pulp, and frequently a rounded cavity is formed extending in all directions as far as the rostrum can reach (Plate XXX, 126). When excavating for purposes of oviposition only, the cavity may not be excavated so broadly. In order that the young grub may develop, the apple containing eggs must drop to the ground. Three or four stings on a fruit

will usually accomplish this result when there is competition among several fruits on one limb. After June 25, or when the apples have attained one-half an inch or more in diameter, many of the fruits will cling in spite of the punctures. No grubs were ever found to develop in the egg-laden apples that remained growing on the tree. Five Baldwin apples on which the beetles had fed and oviposited from June 25 to June 30, are shown in Plate XXX, 125, as they appeared when ready to drop on July 7; the punctures may be plainly seen, and the white exudation at the surface of some of them indicates that in those the young grub had begun activities.

The work of two curculios on a Baldwin apple after July 1 is seen in Plate XXX, 126, the apple being shown in section to expose the egg and feeding cavities. After July 4, very few apples, if any, that were in a strong growing condition when punctured, were found to drop and thus permit the grubs to develop.

One experiment performed was that of caging a pair of beetles from June 16 to July 6 with two Baldwin apples which were on a limb made free of all other fruits. These apples were able to withstand the injuries of the curculios, and grew to maturity with the result shown in Plate XXXI, 127. Another good illustration of the mature scars resulting from injury by the curculio is presented in Plate XXXI, 128, showing two Stark apples.

When growth of the fruit continues following the work of the beetles, the thin tissue and skin immediately above the egg or feeding cavity is found to dry out, usually leaving a white margin as shown in these two figures. A slight depression may result about the point of injury, due to the stoppage of growth, and the scar cavity itself always remains as a sunken brown spot. The most distinctive feature about the mature scar is the white-margined, dried-out tissue, resulting from the thin covering left immediately above the feeding or egg cavity.

The apple curculio was found at work on Bartlett pears in one orchard, making cavities similar to those observed on apples. When beetles were caged with pears, typical feeding and egg laying took place. The mature scars resulting from this experiment are seen in Plate XXXI, 129. The cavities made by the apple curculio on pears were filled out to a certain extent by subsequent growth, a result somewhat different from that obtained on all the apples observed.

The rose chafer

(*Macrodactylus subspinosus* Fabricius)

The adults of the rose chafer are general feeders, eating the fruit and the leaves of many kinds of cultivated and wild plants. The species

breeds in sandy pasture lands, where the grubs feed on the roots of grasses, and if orchards are located in the vicinity of such waste lands much injury may be done to the fruit when the beetles emerge and go forth in search of food and for mating. The writer had opportunity in 1914 to study the result of an invasion of an apple orchard by rose chafers in Genesee County, New York. The beetles were first observed at work on the fruit about June 20, and they continued to feed and mate on the apples until July 4, at which time it became difficult to find them. The trees that suffered the most were those bordering a sandy tract of pasture land, from which the insects evidently came to feed and to which they returned to lay eggs.

The rose chafers were found to eat large, irregular holes in the young apples, the cavity frequently being so large that one or more beetles could conceal themselves in it. Typical feeding scars on Baldwin apples are shown in Plate XXXII, 130, in which one beetle may be seen at work. It was found that the chafers frequently return to the old wounds for feeding, evidently preferring to do this instead of starting on a fresh apple; some beetles were observed to feed on wounds that were at least a week old. All fruits injured by rose chafers were found to shrivel up and drop during July, and so no scars resulted on the fruit. A group of apples showing typical injuries is shown in Plate XXXII, 131, as photographed on July 3; certain of these fruits were injured ten days previous to the time when the picture was made and appear greatly shriveled, while others, which were injured on a later date, indicate how the margin of the wound first shrinks and then curls inward, to be followed perhaps by brown rot. A few days later the same fruits would appear similar to the ones shown in Plate XXXII, 132, which have shriveled and dried out until they are scarcely recognizable. It is apparent that the irregular, rough wounds made by rose chafers feeding on apples are of such character that healing is impossible, and sooner or later the injuries become infected with brown rot, eventually causing the fruits to shrivel and dry up.

DIPTERA

Dipterous pests on the fruit of the apple are few in number, and only one species, the apple maggot, breeds in the fruit and causes economic losses. Ripe apples, and particularly summer varieties, are frequently damaged considerably by swarms of large muscid flies which sip at any point of rupture occurring on the surface of the fruit. Eventually large cavities are produced, and with the introduction of brown rot, decay of the apple is rapid.

The apple maggot

(*Rhagoletis pomonella* Walsh)

In New York the apple-maggot flies may appear in the trees early in July, and when late summer spraying is not practiced the flies soon begin inserting their eggs through the skin of the fruit (Plate XXXIII, 133). The egg puncture appears as a tiny speck, and in those varieties whose growth is not yet completed, a small dimple may form about the point where the egg was inserted (Plate XXXIII, 134). As soon as the apple begins to mellow, the tiny maggots begin to burrow through the pulp in all directions. The maggot works slowly until the apple softens in the ripening process, when it begins to grow rapidly, making winding tunnels through the pulp and quickly reducing the inside of the fruit to a brown pulp (Plate XXXIII, 135). In certain localities where the flies are uncontrolled, the fruit of several summer varieties may be rendered entirely useless.

Maiden Blush apples are grown for the market on a considerable scale in western New York, and in a few orchards, where late summer spraying for the codling moth was not done, the apple-maggot flies began to increase rapidly. A typical example of apple-maggot work on this variety may be seen in Plate XXXIII, 135, photographed in section to show the extent of the tunneling by the maggots. The section on the right exhibits the emergence holes of the mature maggots, brown rot having developed about each tunnel and spread to destroy the whole fruit. A second apple cut in section (Plate XXXIII, 136) illustrates more clearly the tunnels before the brown rot has reduced the pulp to a brown mass, and in this figure mature maggots may be seen as they appear when ready to emerge. Brown rot invariably develops in the maggot tunnels, and this condition appears to be very favorable for development of the maggots.

The apple-maggot fly may lay eggs freely in standard varieties of apples when such apples occur where the flies have become numerous on more favorable fruit. But in such cases the maggots do not develop very rapidly until the ripening process has softened the pulp. The Tompkins King is a variety that becomes sufficiently mellow shortly after being picked to allow the maggots to complete development even after the fruit is packed in barrels. A Tompkins King apple which was bought in the market in October and which appeared to the average consumer as desirable fruit, was packed away until the end of November, with the result shown in Plate XXXIV, 139. On November 29 some of the maggots had emerged, and brown rot could be seen as a discoloration on the surface, indicating that the inside of the apple was practically destroyed.

is shown in Plate XXXIV, 137. In this case so few maggots were at work that brown rot was much delayed in destroying the fruit. The photograph was made just four days after a maggot had emerged from the hole that is surrounded by brown rot.

In Genesee County the writer found the apple maggot breeding freely in crab apples, a condition developing perhaps from the fact that in that locality this variety of fruit rarely, if ever, received the late summer sprays usually given the commercial orchards. In crab apples that are infested, dark tunnels may be seen just beneath the skin, and fruits that are cut in section exhibit typical work of the maggots (Plate XXXIV, 141). The crab apple is firm of flesh and very acid, and this prevents the maggots from making progress until the fruit has lain on the ground for two or three weeks. Crab apples drop freely from the tree and large numbers are usually permitted to remain on the ground to decay, and this condition promotes development of the apple maggot on this fruit.

In some localities it may happen that the apple-maggot flies have developed in considerable numbers on early summer varieties of apples and a second brood emerges to oviposit during September. Either the flies of a second brood or the retarded members of a single brood may attack standard varieties of apples during late September, and the tiny punctures made by the ovipositor will appear as small, black specks from which few or no maggots develop. These spots may be identified by making a section through the puncture, which will usually reveal an egg or a tiny cavity where an egg had been placed.

An interesting case of late oviposition by apple-maggot flies, perhaps the late oviposition work by individuals of a single brood, may be seen in Plate XXXIV, 140, showing a Baldwin apple photographed in October. The punctures made by the ovipositor were situated in small depressions, as is usual, but each incision was surrounded by a dark greenish color of unusual character. A pathological examination of the spots revealed the fact that both the black rot fungus (*Physalospora Cydoniae*) and the New England fruit spot (*Phoma pomi*) had entered and developed in the punctures, probably coming as an infection on the ovipositor of the female fly. The spots produced by stippen, a physiological condition, may sometimes superficially resemble the oviposition marks of the apple-maggot fly, but with the aid of a hand lens one can always recognize the punctures made by the female ovipositor.

HYMENOPTERA

Only two insects in the order Hymenoptera were found affecting the fruit of the apple, and these are rarely present in sufficient numbers to cause economic losses.

The apple-seed chalcis

(*Syntomaspis druparum* Boheman)

The damage done by the tiny apple-seed chalcis to the fruit, slight as it may be, is caused by the female when she inserts her long ovipositor through the pulp in an effort to reach the seeds. The work of the seed chalcis is found only on crab apples and Lady apples, for these are the only cultivated apples that are sufficiently small to permit the female to oviposit in the seeds. The female chalcis is interested merely in placing her egg in the apple seed, where the maggot will develop and remain to pass the winter. The puncture made by the ovipositor leaves a mark on the surface of the apple (Plate XXXIV, 138) which strongly resembles the oviposition scars produced by the apple-maggot fly. Both the apple-seed chalcis and the apple-maggot fly may work on the same fruits, but the individual punctures of the two species are distinguishable by a careful examination of the wound. If the scar is that of the apple-seed chalcis, a section through the puncture to the core will show a slight discoloration and scar along the path followed by the ovipositor (Plate XXXIV, 142). On mature fruits the work of the chalcis fly may otherwise be identified by an examination of the apple seeds, which will show the presence of the larvae. Frequently it may happen that the apple-seed chalcis may breed and become so abundant that crab apples are much stunted and disfigured through the numerous wounds produced by excessive oviposition.

The dock false-worm

(*Ametastegia glabrata* Fallén)

A rather unusual type of injury to mature fruit on the tree has been recorded in Canada as the work of a sawfly larva, *Ametastegia glabrata* Fallén. In the fall of the year the mature larvae desert their wild food plant and go in search of suitable hibernation quarters. When this insect occurs near the apple orchards it may so happen that the larvae will climb up the trees and eat holes in the fruit, excavating cells just large enough to make comfortable hibernation quarters. The writer found an example of this peculiar injury at Ithaca, New York, and a photograph of the sawfly larva in its cell is shown in Plate XXXV, 143. The larva excavates a hole in the flesh of the apple, in depth slightly greater than its own length, thus forming a cell, the opening being closed by bits of the excavated pulp. This insect will probably never cause trouble in well-kept and cultivated orchards.

INJURIES TO THE FRUIT OF THE APPLE BY AGENCIES OTHER THAN INSECTS

The preceding part of this paper deals with specific types of injuries caused by insects, but the person who has occasion to grade or to inspect apples will meet with many other peculiar and little-known scars. In order to recognize all scars arising from insect activities, it was necessary to take into consideration all types of injury that may be found on the fruit. The more important and more frequently met types of injury caused by agencies other than insects, are discussed in the following pages.

WARTING OF SCARS

The peculiar phenomenon exhibited by scars that bulge out beyond the normal surface of the fruit has been designated as *warting* of the scars. The writer has seen this warting produced in scars made by redbugs (Plate XXXV, 144 and 145), by curculios (Plate XXIX, 119), by fruit-tree leaf rollers, by green fruit worms, by tussock moths (Plates XXI, 83 and 84, and XXXV, 146), by apple scab, and by frost injury (Plate XL, 168). It is apparently because of unusual growing conditions that the injuries caused by these several agencies produce the abnormal bulging growth under the scar. This warting of the scars produces peculiar results in some cases (Plate XXXV, 146), and may be explained by accelerated growth late in the season. After the middle of August, apples usually grow very slowly, but occasionally favorable rains after that date force new and rapid growth. When growth is accelerated in the fruit, it is apparent that considerable pressure is exerted on the old and more or less hardened skin. Scar tissue when present, being the most recently formed and tender, gives way first, and new cells are formed beneath the area. In tough-skinned apples such as the Ben Davis (Plate XXXV, 146), the new growth is forced the most completely through the newly formed scar tissues.

MECHANICAL INJURIES

Apples frequently become scarred by rubbing against limbs and by striking stubs or sharp limb ends. In Plate XXXVI, 147, is shown a Rhode Island *Greening* apple which was rubbed constantly by a limb just underneath, from the time it was an inch in diameter until picking time. The russet area is covered with checkered spots of thickened brown corky tissue, all of which was highly polished by the rubbing limb. A Baldwin apple which was blown frequently against a sharp stub is shown in Plate XXXVI, 148. The effect in this case was that holes were punched in the skin of the fruit. A very similar example, only that the punctures were made by a very sharp stub, is shown in Plate XXXVI, 149. Some of the

early wounds healed much as do the scars produced by redbugs, but the later injuries produced a different scar. When the fruit rubs against a limb and there are no sharp points to break the skin, a rough russet surface may be produced on the skin. In another case observed, a Baldwin apple rubbed against a stub from the time it was one-half inch in diameter until it had grown to be one and one-half inches in diameter, when the obstruction was removed. The mature scar (Plate XXXVI, 150) resembled somewhat the scars resulting from slight injury by lime-sulfur spray, but the russet surface was more restricted to a definite area on one side of the fruit than would have been the case with spray burn.

EXPERIMENTS IN PRODUCING SCARS BY PIN PUNCTURES

The peculiar spreading scars that develop on apples injured by feeding redbugs led the writer to experiment on the fruit with fine pin punctures, to ascertain whether the mechanical punctures alone would produce the same type of scar.

In making feeding punctures, *Lygidea mendax* may inject into the wound a poison which affects the fruit differently from ordinary punctures. The peculiar festering noted in the wounds made by feeding redbugs, and their subsequent development, are so characteristic that it seems very probable that some secretion of the bug plays an important part. The writer made dissections of nymph and adult heads of *L. mendax* in an effort to locate poison glands, but if such were present they were so small that he failed to find them.

The bug when feeding will at intervals raise and lower its proboscis in the wound, evidently lacerating the pulp cells in order to obtain a greater flow of sap. Experiments in imitating redbug wounds were made by using a No. 0 insect pin to make the punctures. On June 7, when the young apples were not more than a half inch in diameter, a large number of fruits were treated in this way. The mature result of some of these pin punctures on a Rhode Island *Greening* apple is shown in Plate XXXVI, 151. The pin punctures did not produce a characteristic festered wound such as is made by redbugs, with the subsequent splitting of the adjacent skin and development of russet scars.

CRACKING FRUIT

One frequently finds apples that are circumscribed by large and extensive cracks, and in most cases these appear to be the result of steady growth. In all cases it would appear that cracks on the surface of the fruit are due to a hardening of the skin before the normal size of the apple is attained. When the skin loses its ability to expand and take care of the increase of size required by growth, the natural result is the forma-

tion of cracks on the surface to permit of the necessary increase in size due to growth pressure within. The Roxbury is an apple which frequently exhibits cracks, and this might be expected, due to the unusual type of skin that this variety possesses (Plates XXXVI, 152, and XXXVII, 153). Certain fruits that have been excessively scarred by insects may develop cracks in the dry, hard skin as a result of expansion by later growth. Two Rhode Island *Greening* apples which were largely covered by the broad russet scars resulting from redbug injury, developed cracks as shown in Plate XXXVII, 154, photographed in August. An interesting example of the habitual development of large, broad surface cracks was to be found on a Baldwin tree, one large limb of which always produced fruit with a thick russet skin and broad cracks (Plate XXXVII, 157). That part of the tree which produced these strange russet apples, so unlike the typical Baldwin apples that grew on other parts of the tree, was evidently a sport development and always produced fruit with a thick, tough skin that must necessarily crack during growth.

LIME-SULFUR SPRAY INJURY

Lime-sulfur spray as ordinarily used — 1 to 40 — will, if the young fruit is drenched, cause slight burning, but the extent of injury depends much on the variety affected. The Tompkins King apple is particularly tender, and it is this variety that shows oftenest the effects of spray injury (Plate XXXVIII, 158). In many cases the injury results in russet scars which in some respects may resemble the work of redbugs. In Plate XXXVII, 156, is shown a perfectly shaped Baldwin apple which has typical russet scars produced by slight burning from lime-sulfur at the time of the calyx spray. This type of scar may usually be recognized by the many fine and irregularly placed russet streaks and cracks.

SUN-SCALD

Sun-scald is the name usually applied to the excessive burns that may result from late summer spraying when the sunshine is bright and the atmospheric temperature high. A good illustration of this was observed in 1914, when spraying was done on August 4 and August 5 for the second brood of codling moth. On both days the sunshine was very hot and the temperature ranged from 90° to 100° F. All apples that were well covered with the spray and then exposed to the sunshine for three or four hours developed a characteristic burn. Four days later, or on August 9, the results of the sun-scald attracted attention. Two Rhode Island *Greening* apples as picked are shown in Plate XXXVIII, 160; the dark color of the scalded spots shows through the coating of arsenate of lead and lime-sulfur. In the case of Baldwin apples that developed sun-scald, the dark scalded area showed clearly in contrast with the red color of the

fruit. The cells beneath the scalded spots were killed to a depth of from one-eighth to one-fourth inch, and turned dark brown within four days after the burn occurred. A section through a scald spot on a Baldwin apple, which was typical of the average burn, shows the brown color penetrating to not more than one-eighth inch (Plate XXXVIII, 159). One of the same Baldwin apples is shown in Plate XXXVIII, 161, with a mature scald scar as it appeared on October 21. The burned tissue turned brown and dried out, only to be followed later by the formation of large cracks in the dead tissue.

SCARS PRODUCED BY FROST INJURY

The writer observed that frost injury to young apples may develop into scars that very much resemble the large russet scars made by redbugs. The spring of 1915 was a season when frost was noted in many localities in western New York. A frost occurred on the morning of May 28, which was soon after the young apples had set. The apples that recovered from the injury developed a characteristic scar band, usually extending around the middle of the fruit but in some cases appearing either nearer the base or toward the calyx (Plates XXXIX, 167, and XL, 171). The first apples observed to be recovering and exhibiting effects of freezing were found on June 16 (Plate XXXVIII, 162). The apples that were killed by the frost were dropping off rapidly on the same date. Many orchards that were situated in valleys had all the fruit killed, while other orchards, located on hillsides, had only part of the fruit killed. In some places it was possible to locate within a few inches the highest point that the frost level reached. In such orchards one could find fruits exhibiting all stages of freezing, which were indicated later by corresponding scars on the apples that recovered. A Northern Spy apple from an orchard in which nearly every apple was killed is shown in Plate XXXIX, 163; practically the whole surface is covered with russet, and during later stages of growth several large cracks occurred in the skin.

Scars resulting from frost injury can usually be recognized by the splitting of the skin along the axis of the fruit, which makes the scar band uneven (Plate XL, 168 and 169). Many fruits, however, exhibit practically a continuous band of russet which corresponds to the surface that was frosted on the young apple. The location of the band has much to do with the growth of the apple and its shape at maturity (Plate XXXIX, 166 and 167). Certain apples were only slightly frosted, and in these cases the scars appeared in only two or three places around the circumference of the fruit. In such fruits the scars were sometimes difficult to distinguish from the injuries produced by redbugs. Isolated frost scars always appear as splits along the axis of the fruit (Plate XL, 168).

while the scars produced by redbugs are very irregular and extend in all directions. Frequently the splits occurring along the axis of the fruit are reduced to four or five in number and are grouped at one end (Plate XL, 169). The seeds were always killed in badly frosted apples, and many apples that grew to large size exhibiting frost bands were found to contain only one or two seeds. Frost bands were even distinguishable on the surface of russet apples. In Plate XL, 170, three Golden Russet apples are shown with typical frost bands and cracks, the extent of which may be readily recognized on the normal russet surface.

In those orchards where the frost was most severe and all the fruit was apparently frozen, it was possible to find clusters of stunted, russet-covered apples wherever the rosy aphid had developed and was present on the cluster at the time when the frost occurred. These fruits were worthless, but were of interest as indicating the influence the aphids had in causing the frozen fruit to cling through the growing season.

HAILSTONE INJURY

The scars resulting from hailstone injury may assume various shapes and forms. On isolated fruits such scars are in some cases difficult to distinguish from certain insect scars. If the hailstone injury occurs early in the season, while the fruit is growing rapidly, many of the apples will recover and exhibit scars that resemble somewhat the work of tussock-moth larvae or the very early intermittent feeding of the green fruit worms. An apple having four hailstone scars which were inflicted early in July, and one small scar produced by a green fruit worm in June, is shown in Plate XLI, 176 (photographed on August 23). The hailstone scars invariably exhibit a considerable amount of dead, corklike tissue resulting from the drying-up of the injured cells. In the case of Baldwin apples observed, which were injured by hail on July 20 and examined on September 25, the bruised cells were found to turn brown, dry out, and then crack and fall away. Usually some of the corklike cells are left clinging to the inside of the pit.

A Baldwin apple that was injured on July 20 is shown in Plate XLI, 173, as photographed on August 4; deep-sunken pits were produced, and the cells immediately beneath the scars turned brown and dried out. Sections at two different levels immediately beneath such spots are shown in Plate XL, 172, indicating the depth of the wound and the way the tissue dries out. A Baldwin apple which was injured by a large angular hailstone is seen in Plate XLI, 174. Baldwin apples severely injured by hail on July 20, exhibiting large, angular scars more or less filled with the dead and dried-out tissue, are shown in Plate XLI, 175 and 178, in the

stage of recovery that was attained by August 17. Even crab apples, small as they are, may show the same type of ugly wounds due to hailstone injury as are found on the standard varieties of apples (Plate XLI, 177).

APPLE SCAB

Apple scab causes much injury to apples even in orchards that are well sprayed, and is a factor that often enters into combination with other scars to disfigure the fruit. Typical scab spots usually exhibit a characteristic papery edge around the margin of the scar, which represents the cuticle of the skin that is left by the fungus (Plate XLII, 179). After a time the scab spots may lose this character and appear as dark-colored, irregular blotches. Late scab infection occurring during early September, may cause red color to develop around the point of infection, thus giving a superficial resemblance to San José scale (Plate XII, 37). Very soon, however, the scab spots grow larger and acquire a characteristic dark color at the center (Plate XLII, 181). The old scab scars may become smooth and even russet-colored by the time the fruit is matured, and when conditions are right for producing growth late in summer, warting of the scars may take place. An excessive amount of scab grouped on one side of the apple may dry out the surface to such an extent that large cracks will appear (Plate XLII, 180).

STIPPEN

Large and over-grown Baldwin apples may frequently exhibit small, discolored spots, somewhat resembling the spots from which scale insects have been removed. Such imperfections are caused by a physiological disease known as stippen. When a stippen spot occurs in connection with an enlarged lenticel of the skin, it may be somewhat suggestive of an oviposition mark made by the apple-maggot fly. A section through such spots, however, will reveal the true cause. Stippen may be recognized in section by the numerous brown discolorations caused by the dying and drying-out of groups of cells throughout the flesh of the fruit, and particularly at the surface (Plate XLII, 182).

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Plate III

THE FIELD INSECTARY AT BATAVIA, NEW YORK

This was equipped with skylight and dark room, and served in the production of practically all the negatives from which prints were made for this thesis

Plate IV

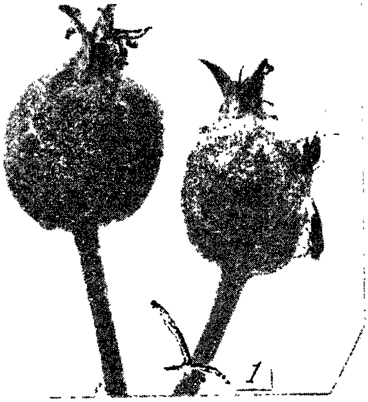
INJURIES PRODUCED BY LYGIDEA MENDAX

1, Rhode Island *Greening* apples with nymph and adult redbugs, showing the injuries they produce. Photographed on June 18

2, Redbug injuries on Northern Spy apple. The scars are spreading and joining one puncture with another. Photographed on July 8

3, Northern Spy apple showing mature scars which on July 8 were very similar to those shown in figure 2. Photographed on September 22

4, Rhode Island *Greening* apple (at left) and Tolman apple (at right), showing typical deeply pitted redbug injuries on the mature fruit. Photographed on October 21



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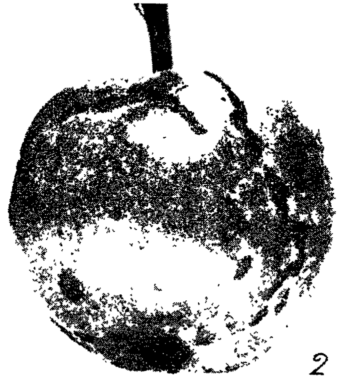

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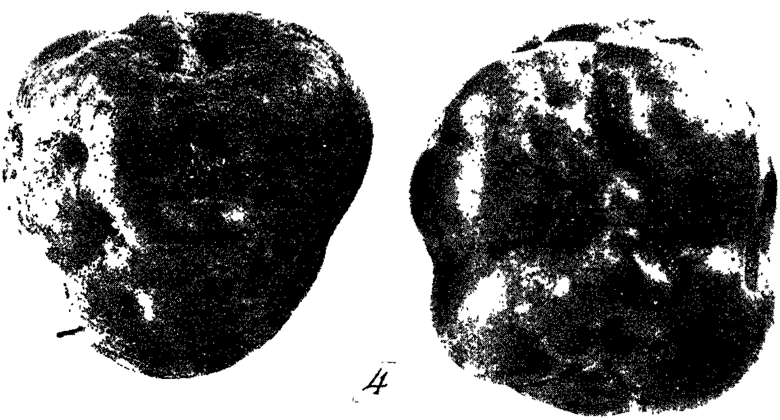

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Plate V

INJURIES PRODUCED BY LYGIDEA MENDAX

5, Baldwin apples showing the beginning of russet scars, the punctures having been made from seven to ten days earlier by the feeding redbugs. Photographed on June 24

6, Baldwin apples showing the development of russet scars on July 3, practically two weeks after the punctures were made by the feeding redbugs

7, Roxbury apples in section, showing the condition of the tissue surrounding points of puncture made by redbugs in June. Photographed on August 30

8, Northern Spy apple showing the deep pits resulting where redbugs fed on the fruit and made punctures that reached the core. Photographed on August 25

9, Mature Rhode Island *Greening* apple showing a few deep pits resulting from redbug punctures which are very suggestive of plum curculio work

PLATE V

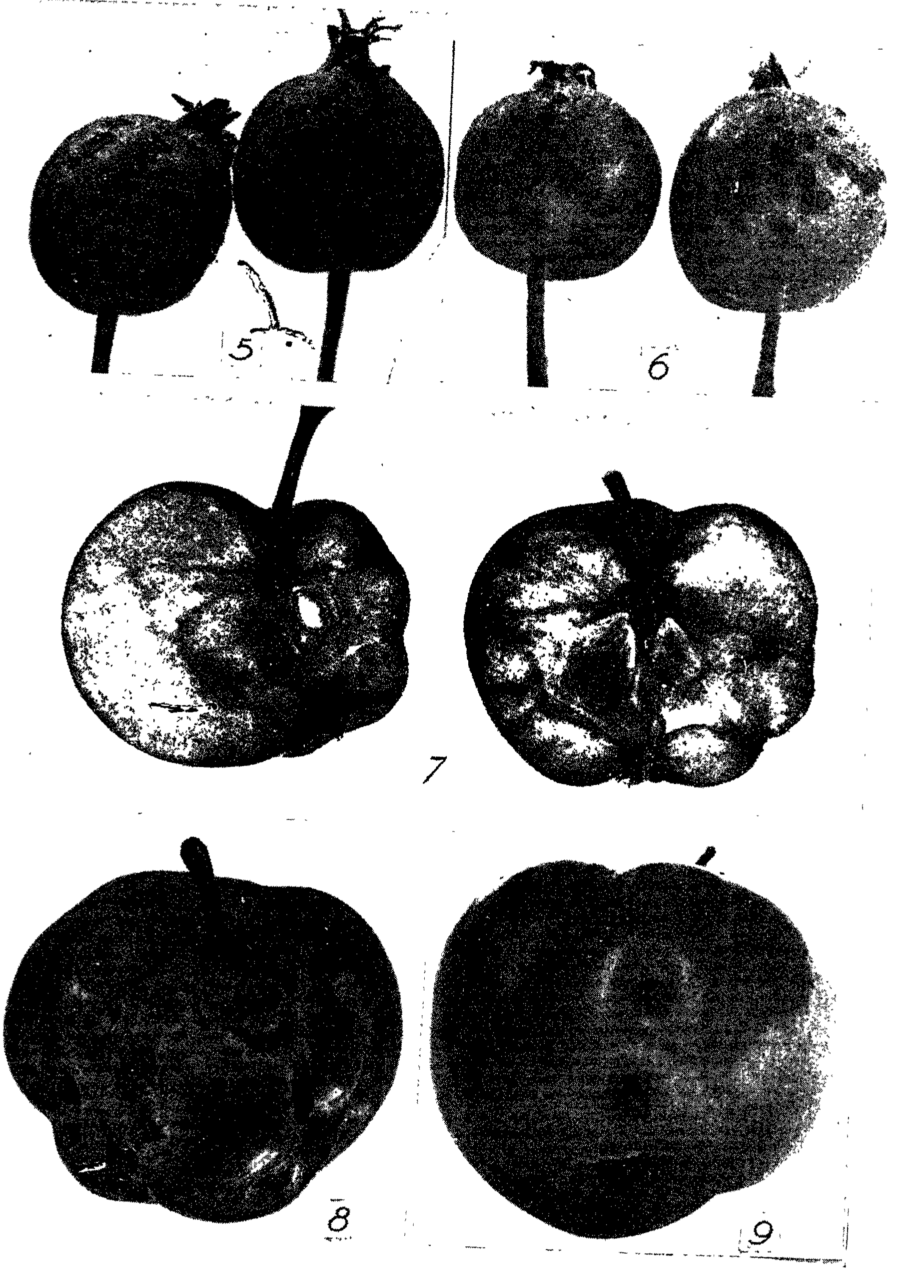

PLATE VI

INJURIES PRODUCED BY LYGIDEA MENDAX

10, Maiden Blush apple showing the scars resulting from the feeding of adult redbugs. Photographed on September 20

11, Tolman apple showing the mature scars resulting from feeding punctures of adult redbugs. Photographed on October 23

12, Mature Northern Spy apple illustrating the result when redbug punctures that have reached the core tissue occur along one or two definite lines

13, St. Lawrence apple on which the russet type of redbug scar changes to smooth, brassy, russet-colored scars. Photographed on July 28

14, Rhode Island [illegible] apple photographed on July 7, showing character of scars on that date

15, Golden Russet apples showing deep pits and russet scars caused by redbugs. Photographed on July 13

16, Work of redbugs on natural fruit, exhibiting all types of scars. Photographed on July 6

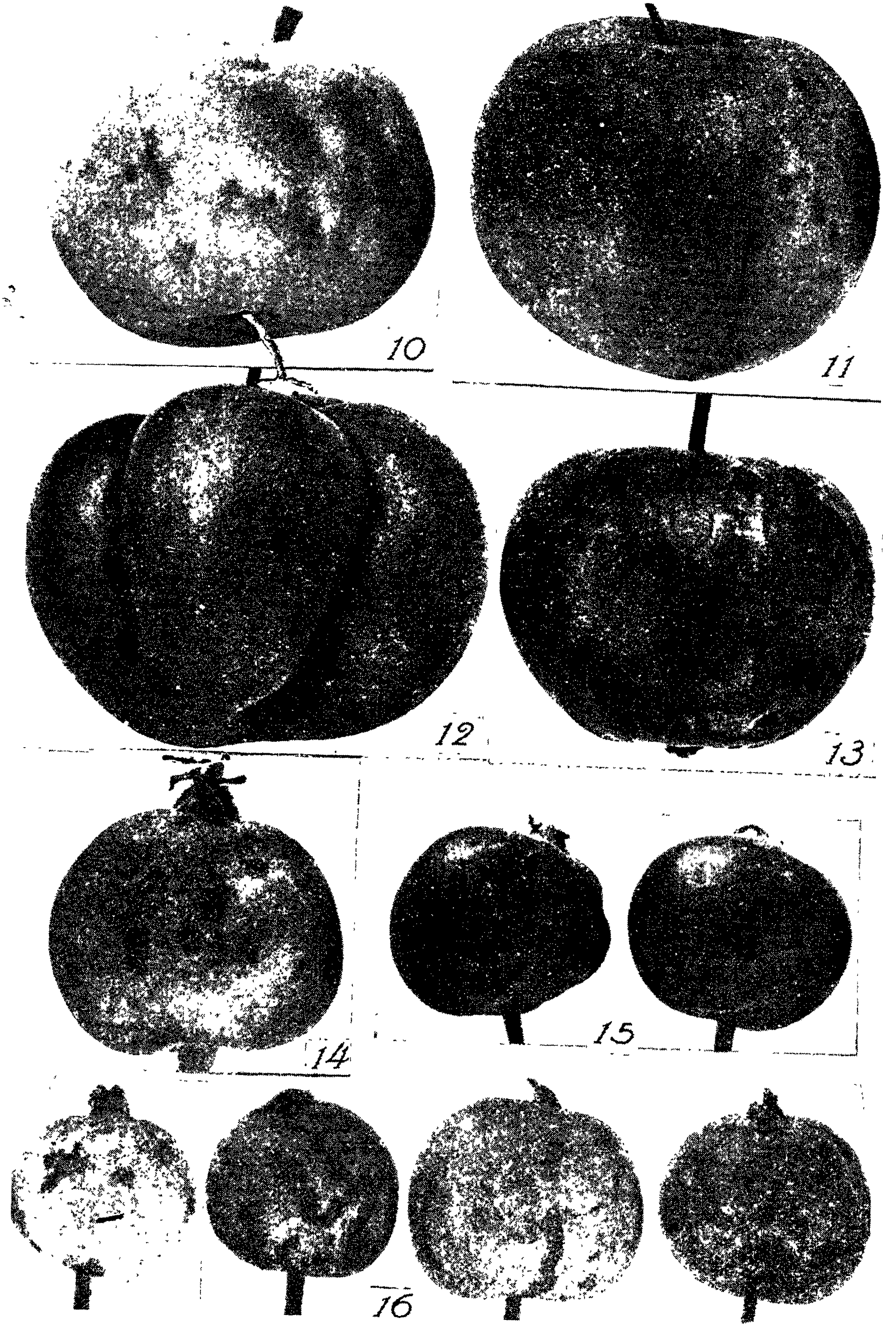
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Plate VII

INJURIES PRODUCED BY LYGIDEA MENDAX AND BY APPLE SCAB

17, Rhode Island *Greening* apples showing an early stage of redbug scars, photographed on July 7 for comparison with apple scab spots shown in figure 18

18, Apple scab spots photographed on July 7 and shown for comparison with redbug scars

19, Roxbury apples showing both the pitted and the russet type of scars, the russet scars being little different from the natural skin of the fruit

20, Mature russet scars caused by feeding redbugs on an unnamed variety of apple having a polished, light-colored skin. Photographed on September 25

21, Baldwin apple which was badly injured by feeding redbugs in June but recovered and grew to maturity exhibiting russet scars. The remains of a young apple that was killed by the feeding bugs may be seen

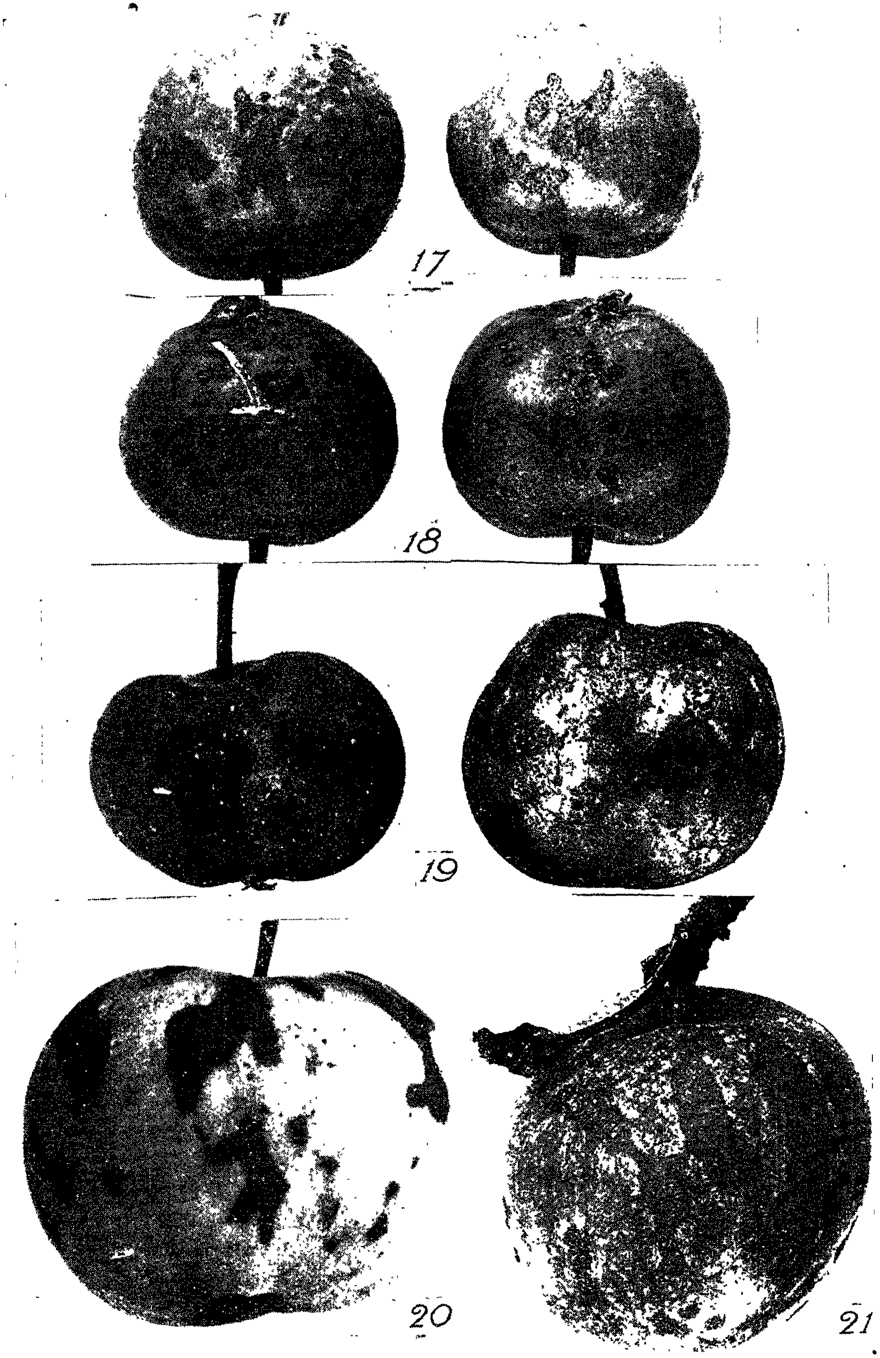
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Plate VIII

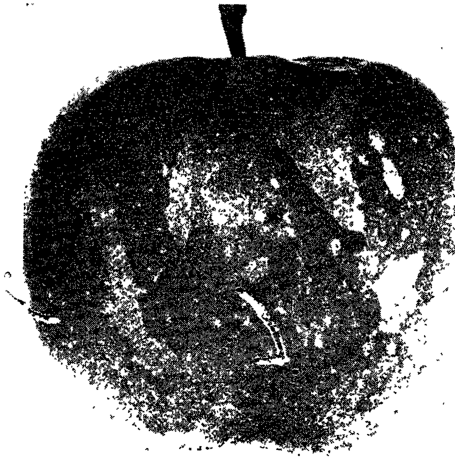
INJURIES PRODUCED BY LYGIDEA MENDAX AND BY APHIS SORBI

22, Baldwin apple, perfect in shape but showing the more or less smooth, russet type of redbug scars. Photographed on September 27

23, Roxbury apple punctured by feeding redbug nymphs in June. This developed into a perfectly shaped fruit, but it exhibits russet scars which show in contrast with the natural russet color of the fruit. Photographed on September 7

24, Baldwin fruits that were severely injured by feeding redbugs, followed by an infestation of *Aphis sorbi*. Such wounds become enlarged by the action of the aphid, exhibiting a frothy exudation and an enlargement of the scar by the splitting of the skin at certain points. Photographed on June 25

25, Rhode Island *Greening* apples photographed on September 21, which on June 25 were in a very similar condition to the fruits shown in figure 24, fruits that were first punctured by redbugs and then suffered from an infestation of *Aphis sorbi*



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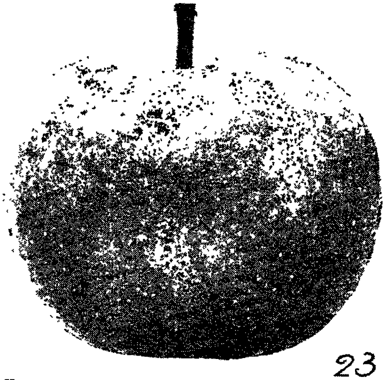

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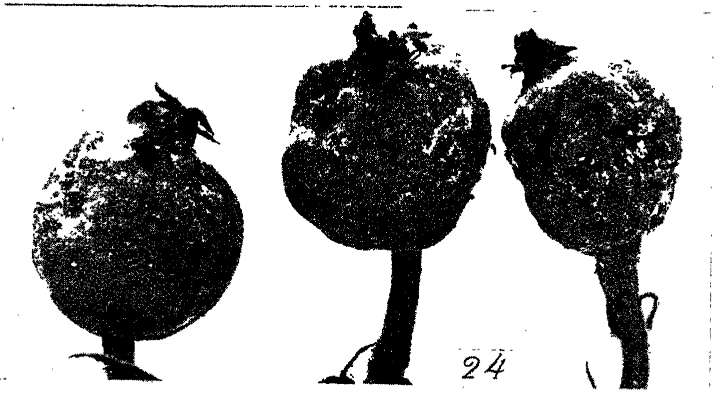

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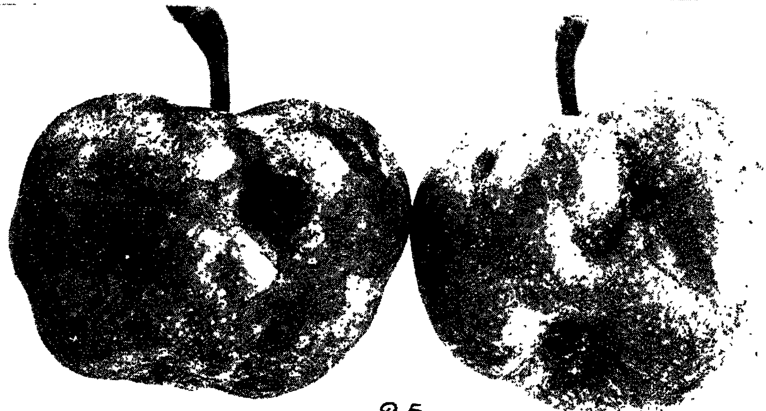

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Plate IX

INJURIES PRODUCED BY LYGIDEA MENDAX, HETEROCORDYLUS MALINUS, AND APHIS SORBI

26, *Heterocordylus malinus.* A female bug, heavy with eggs, feeding on a young apple. Photographed on June 18

27, Mature quinces photographed on September 18, showing the scars resulting from the feeding of redbug nymphs of *Lygidea mendax* in June

28, A Twenty Ounce apple, and a slice from a second fruit, which show the mature scars caused by redbugs. In all probability this is the work of *Heterocordylus malinus*

29, A cluster of six Baldwin apples, photographed on June 24, showing typical work of *Aphis sorbi* at that date

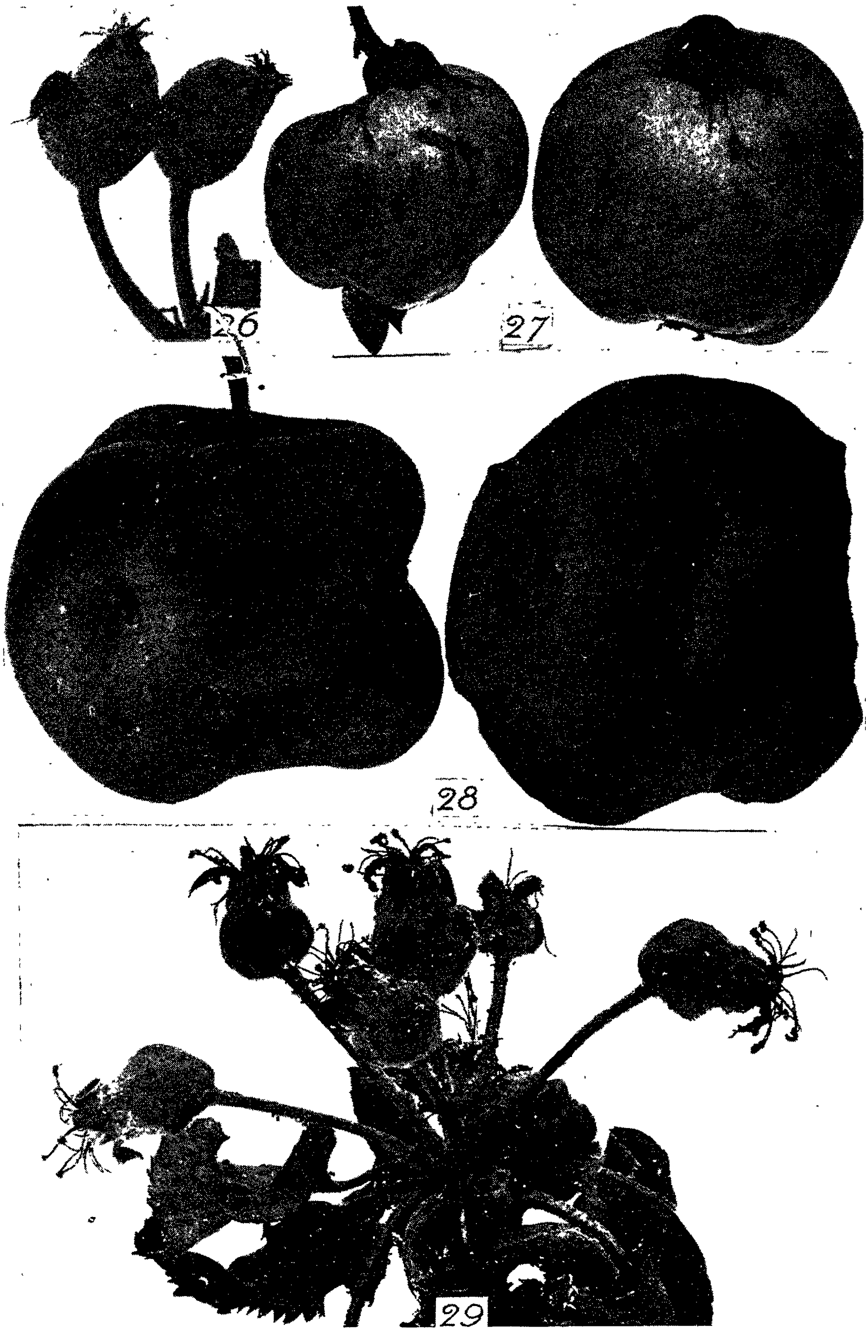

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Plate X

INJURIES PRODUCED BY APHIS SORBI

30, A cluster of six Baldwin apples which were infested by *Aphis sorbi* in June and photographed on the tree on July 4

31, The same cluster of apples as is shown in figure 30, as they appeared at the end of the growing season. Photographed on September 25 (nearly natural size)

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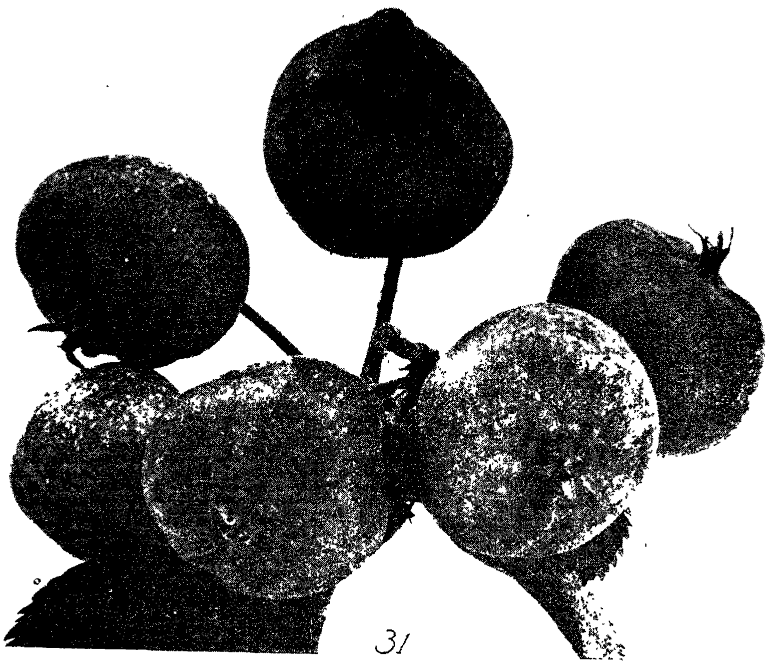

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Plate XI

INJURIES PRODUCED BY APHIS SORBI AND BY A. POMI

32, Pippin apples showing a puckered appearance at the stem end, or base of the fruit, a condition usually seen only at the calyx end and resulting from an infestation of *Aphis sorbi*

33, A cluster of Baldwin apples which were first infested with *Aphis sorbi*, followed by *Aphis pomi* during the period between June 25 and July 20. The dark, smutty appearance results from the work of a fungus on the honeydew secreted by *Aphis pomi*. Photographed on August 4

34, Apples showing the black, smutty appearance that results from the development of a fungus on the honeydew secreted by *Aphis pomi*. Photographed on August 4

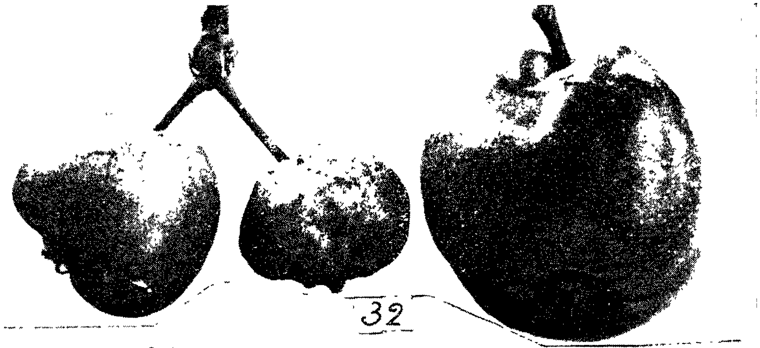

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Plate XII

INJURIES PRODUCED BY ASPIDIOTUS PERNICIOSUS, APPLE SCAB, AND CARPOCAPSA POMONELLA

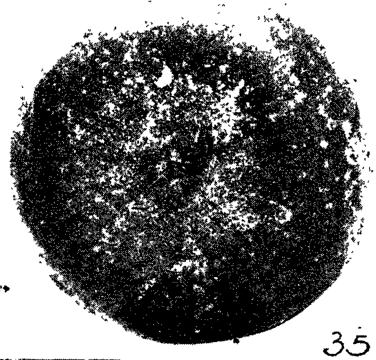
35, Baldwin apple which shows a heavy infestation of San José scale on the calyx end of the fruit. Photographed on November 29

36, Mann apple showing the characteristic development of red color about the scales. Photographed on November 29

37, Maiden Blush apples which developed late scab infections and show color about the scab spots, superficially resembling the spots made by San José scale. Photographed on September 18

38, Baldwin apple cut in section, showing a mature codling-moth larva in its burrow. Photographed on July 8

39. Rhode Island *Greening* apple in section, showing a typical burrow and the nearly full-grown codling-moth larva. Photographed on August 4



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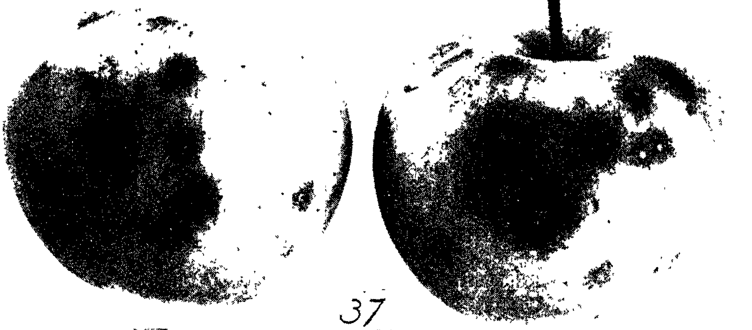

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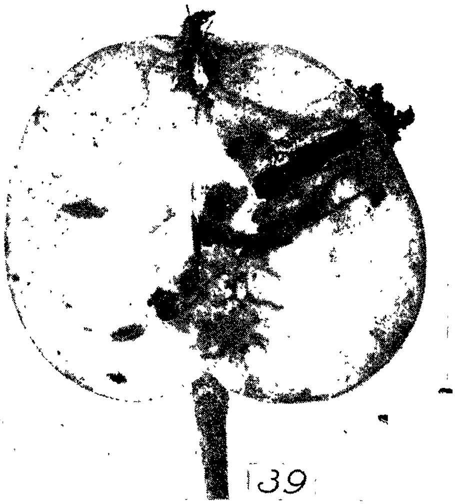

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Plate XIII

INJURIES PRODUCED BY CARPOCAPSA POMONELLA

40, Apples spread apart to show the work of codling-moth larvae where the fruits rested in contact. Photographed on July 28

41, Fall Pippin apple showing the work of second-brood larvae during September. Each white frothy spot indicates where a larva was trying to enter the fruit. Photographed on September 18

42, Slices from apples that show "side-worm" injury produced by late-appearing larvae of the first brood. The larvae were poisoned, but did not die before making a small hole in the fruit. Color develops around the spots much as it does around scale insects. Photographed on August 4

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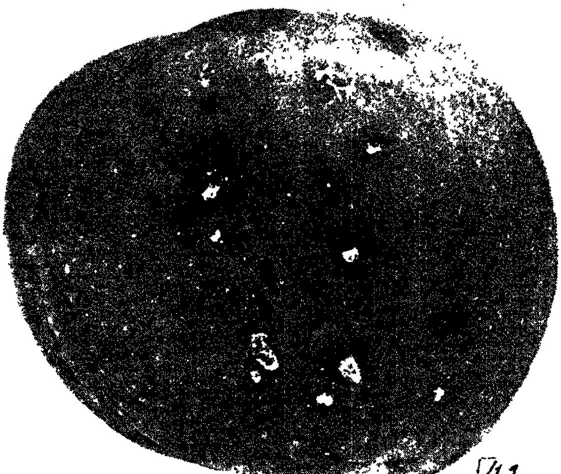

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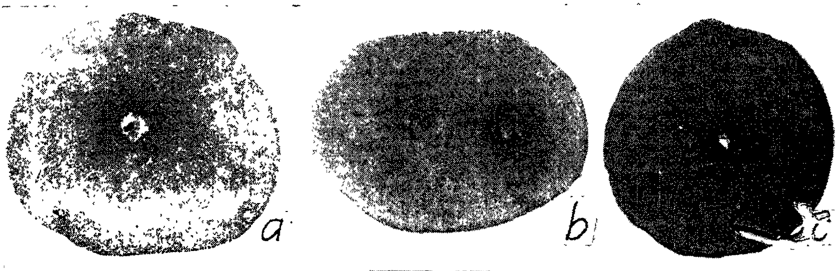

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Plate XIV

INJURIES PRODUCED BY CARPOCAPSA POMONELLA AND BY ENARMONIA PRUNIVORA

43, Rhode Island *Greening* apple showing two larval exit holes, indicating that two codling-moth larvae had developed in the fruit. Photographed on September 26

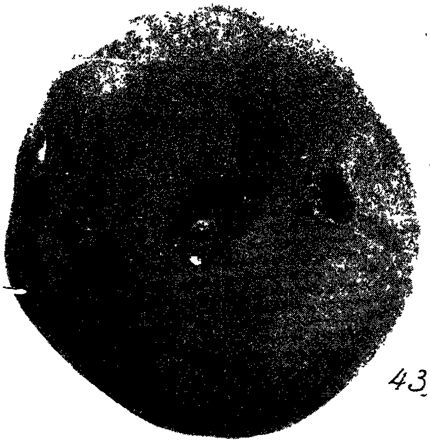
44, The apple shown in figure 43, in section, exhibiting the two larval burrows. Brown rot may be seen developing along the right-hand burrow

45, Baldwin apple showing the work of Pollenia and other muscid flies, which frequently enlarge the "side-worm" holes made by codling-moth larvae. Photographed on September 3

46, Baldwin apple showing the white frothy spot where a late-appearing codling-moth larva of the first brood entered into the scar cavity made by a leaf-roller larva. Photographed on July 20

47, Slices from apples showing "side-worm" injuries produced by second-brood codling-moth larvae in September. The larvae were dead except in the left-hand slice, which shows a white exudation from the spot. Photographed on September 9

48. Sections of apple showing (at right) the surface work of the larva of *Enarmonia prunivora* in an apple, and (at left) the tunnels just beneath leading to the core. Photographed on September 9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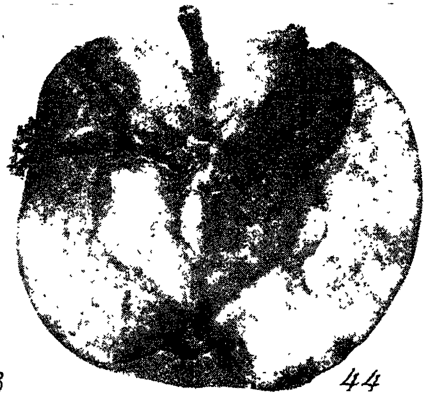
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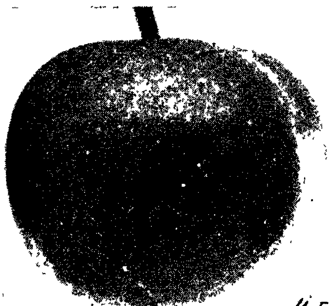
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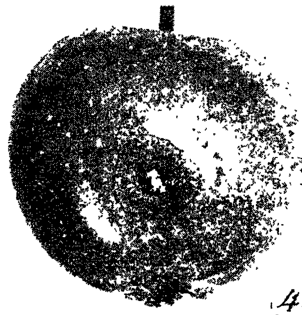
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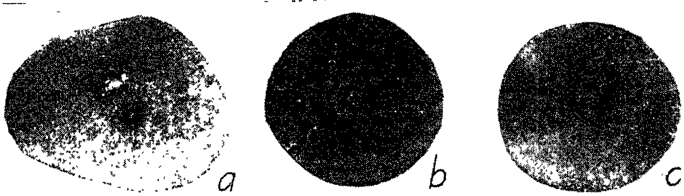
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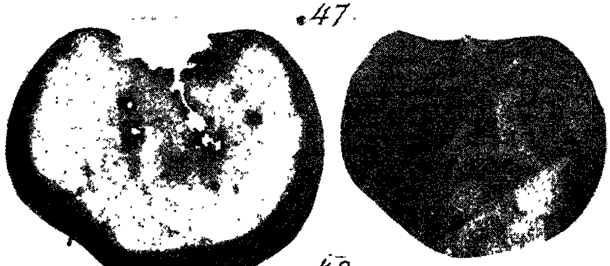
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Plate XV

INJURIES PRODUCED BY ARCHIPS ARGYROSPILA

Vork of a leaf-roller larva in destroying a fruit cluster, showing how the leaves and g fruits are webbed together. Photographed on June 9

leaf-roller larva protruding from its rolled leaf retreat, and the apple next to ich the larva fed. Photographed on June 9

Rhode Island *Greening* apples showing types of fresh scars made by leaf-roller Photographed on June 24

Additional fruits that show typical leaf-roller scars found on June 24

Pippin apples showing deep and narrow scars. These fruits had part of their cores , but were able to recover and grow to maturity. Photographed on September 19

Twenty Ounce apples that show deep cavities made by feeding larvae. Two of these ere recovering, while the specimen in the center had succumbed to the injuries Photographed on July 8

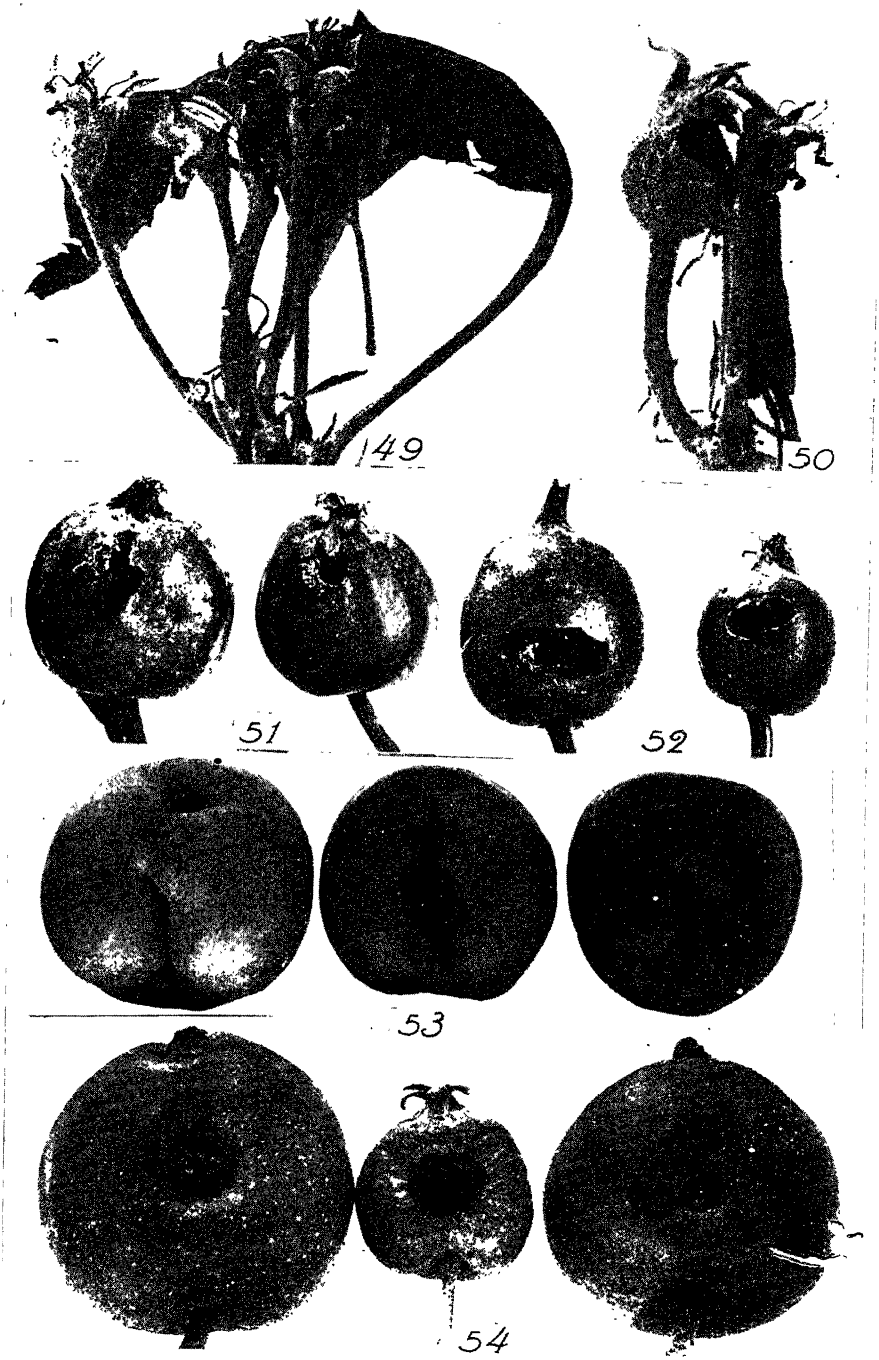
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Plate XVI

INJURIES PRODUCED BY ARCHIPS ARGYROSPILA AND BY XYLINA ANTENNATA

55, Apples showing scars made by leaf-roller larvae. Photographed on July 7

56, Apples showing scars made by *Xylina antennata,* to be compared with the work of the leaf-roller larvae shown in figure 55. Photographed on July 7

57, Baldwin apples exhibiting deep scars made by leaf-roller larvae. Photographed on August 30

58, Twenty Ounce apple showing how the deep cavity made by a leaf roller has grown out and nearly filled the original cavity. Photographed on October 21

59, Roxbury apple showing a small, shallow scar made by the late feeding of a leaf-roller larva. The large crack which encircles the apple was caused by growth pressure after the skin of the fruit had become hardened

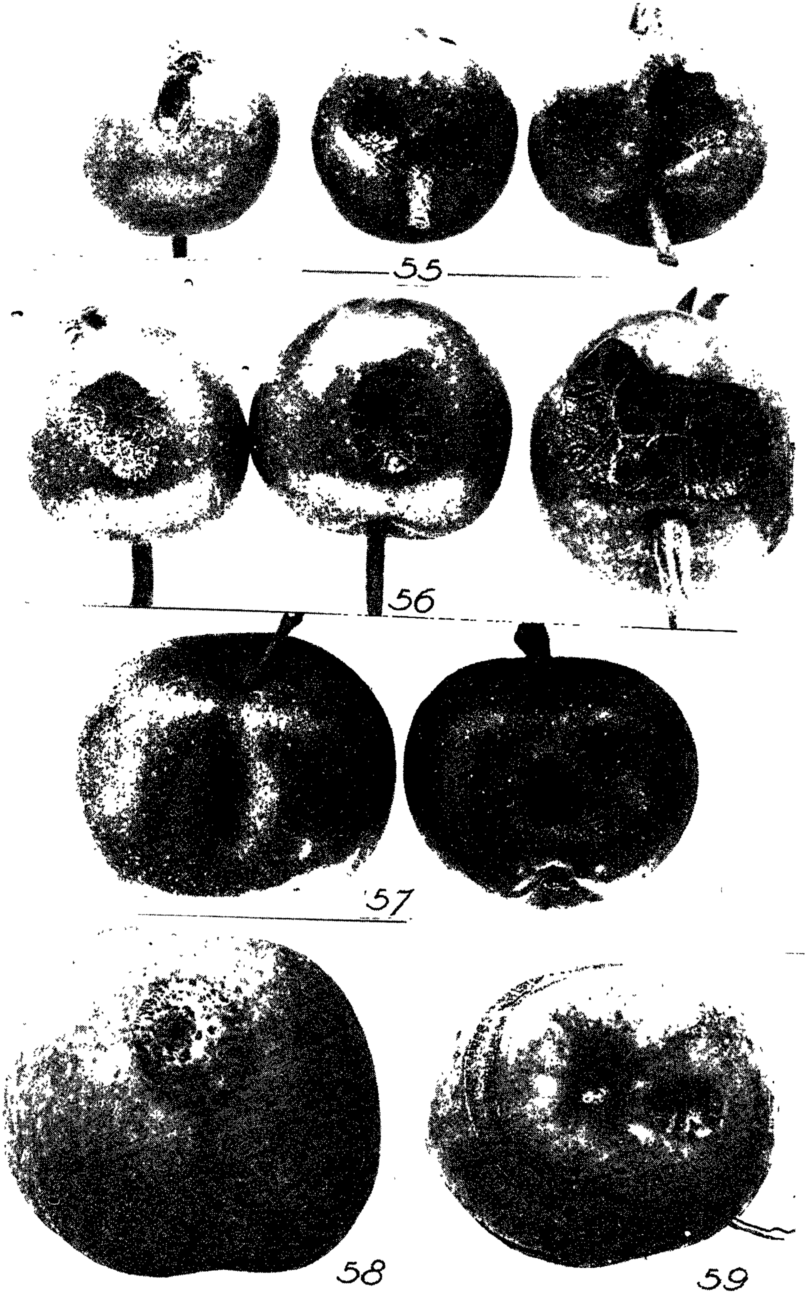
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Plate XVII

INJURIES PRODUCED BY XYLINA ANTENNATA

60, Comparison between the injury made by a leaf-roller larva (left) and the feeding work on young apples of a green fruit worm (right). Photographed on June 12

61, Nearly full-grown larva of *Xylina antennata*, feeding, with its head in a young apple. Photographed on June 12

62, Scars made by a fruit worm on June 20, photographed on June 24 after the wounds have turned brown. These fruits have just attained the size which would enable them to recover from shallow wounds such as are shown

63. Apples showing scars made by fruit worms on June 18, photographed on June 24 when the scar tissue was just beginning to form

64, Apples photographed on June 24, showing scars produced by young fruit-worm larvae about June 8 to June 10 The scars were so small that the fruits were recovering

65, Bartlett pears showing mature scars caused by the feeding of one fruit-worm larva in June. Photographed on September 9

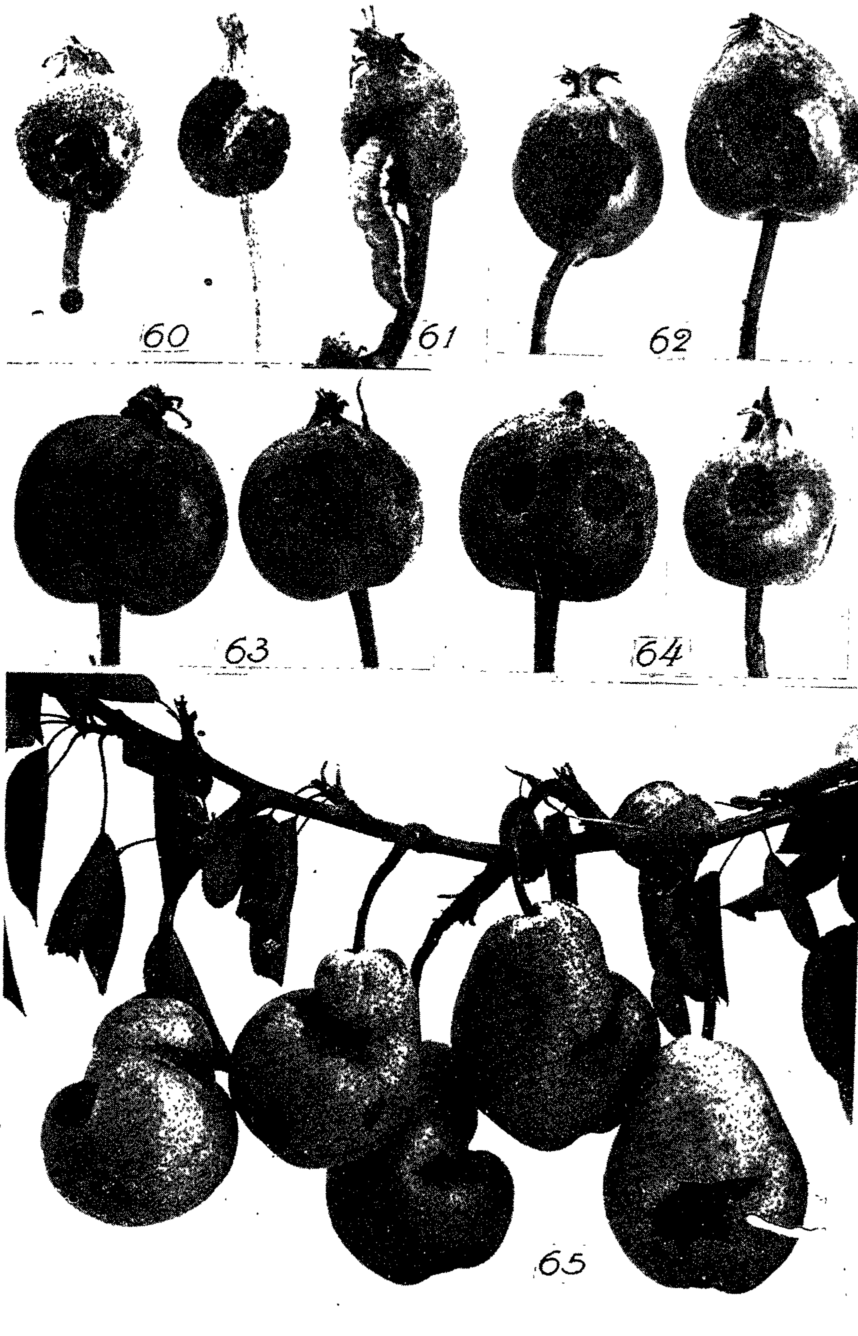
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Plate XVIII

INJURIES PRODUCED BY XYLINA ANTENNATA

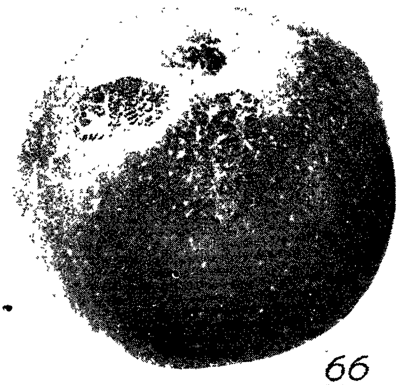
66, Rhode Island *Greening* apple showing mature scars produced by the intermittent feeding of fruit-worm larvae at a time when the fruit was not more than half an inch in diameter. Photographed on August 14

67, Pippin apple showing excessive injury by a fruit-worm larva, the apple, however, continuing to grow. Photographed on November 1

68, Baldwin apple, natural size, showing that the core was reached by a feeding fruit-worm larva, and yet the fruit recovered and grew to maturity. Photographed on November 1

69, Tompkins King apple showing a large fruit-worm scar, this case being unusual in that two scars joined to form one large irregular one. Photographed on September 9

70, Baldwin apples showing typical broad fruit-worm scars. Photographed on August 23



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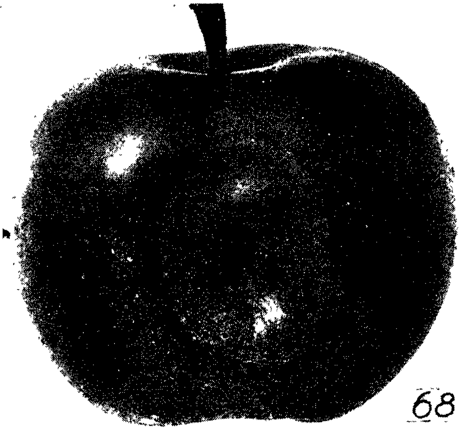

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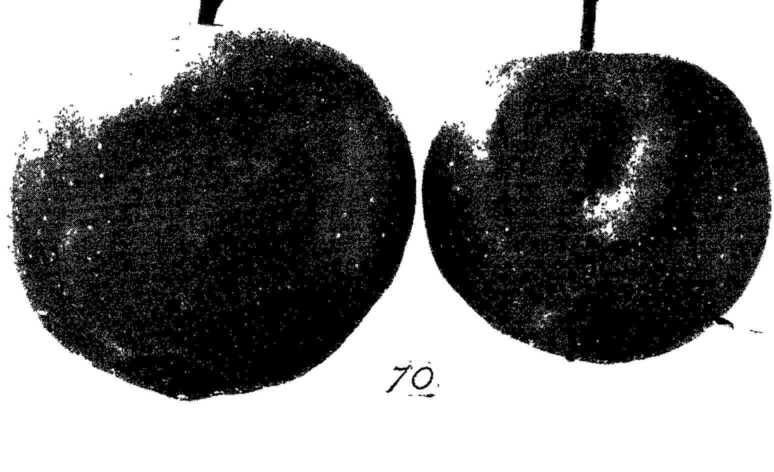

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Plate XIX

INJURIES PRODUCED BY XYLINA LATICINEREA, RHYNCHAGROTIS PLACIDA, AND HEMEROCAMPA LEUCOSTIGMA

71. A larva of *Xylina laticinerea,* nearly full-grown, and four young apples on which it had been feeding. Photographed on June 18

72. Rhode Island *Greening* apple on which a larva of *Rhynchagrotis placida* fed from June 16 to June 19. Picked and photographed on August 16

73. Baldwin apple showing mature scars produced by a larva of *Rhynchagrotis placida* feeding on the young fruit in June. Photographed on September 21

74. Rhode Island *Greening* apples showing two tussock-moth larvae at work, and the typical scars, on June 24. The small apple at the right had received excessive injury, which would result in its early dropping

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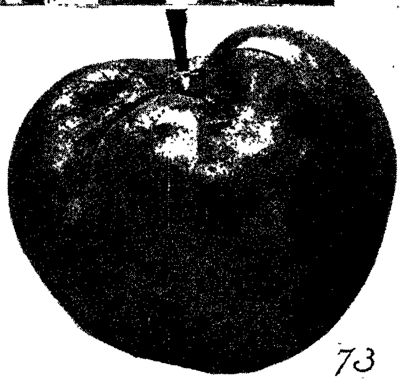

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Plate XX

INJURIES PRODUCED BY HEMEROCAMPA LEUCOSTIGMA

75, Work of one tussock-moth larva on a Rhode Island *Greening* apple. The larva was found at work on the apple on June 29, and it continued to feed until it was photographed on July 3

76, Baldwin apples which were recovering from injury, each apple showing several of the small, shallow scars that are characteristic of tussock-moth work. Photographed on July 4

77, Twenty Ounce apple showing the typical scars that result from tussock-moth work. Photographed on August 30

78, Rhode Island *Greening* apple showing the large, shallow scars, with irregular margins, characteristic of large scars made by the tussock-moth larva. Photographed on September 22

79, Northern Spy apples showing the long, slender feeding channels of the larva, this being a characteristic injury after the skin of the fruit has become hardened. Photographed on July 20

80, Twenty Ounce apple showing a scar that did not heal perfectly, due to the fact that the injury was received after active growth had stopped. Photographed on August 30

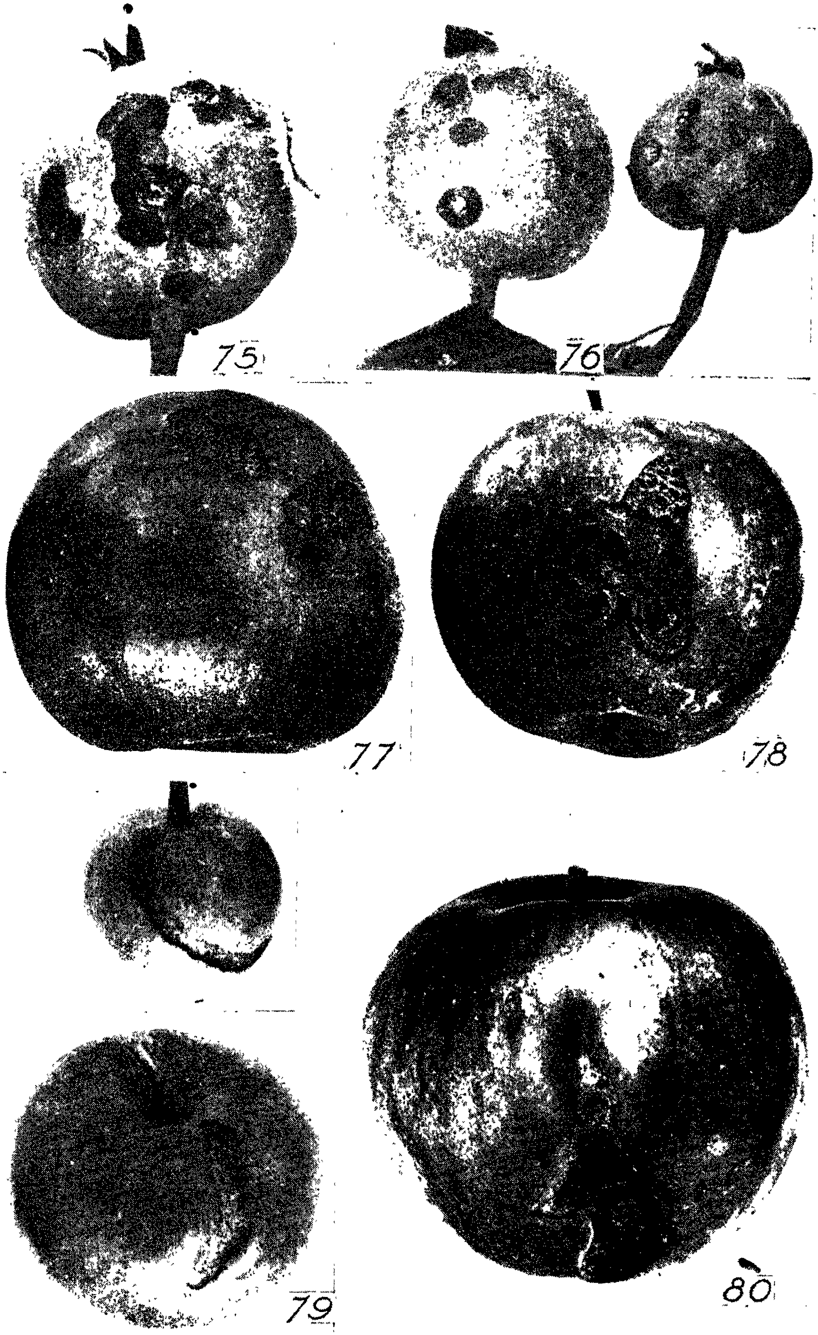
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PLATE XXI

INJURIES PRODUCED BY HEMEROCAMPA LEUCOSTIGMA AND BY YPSOLOPHUS LIGULELLUS

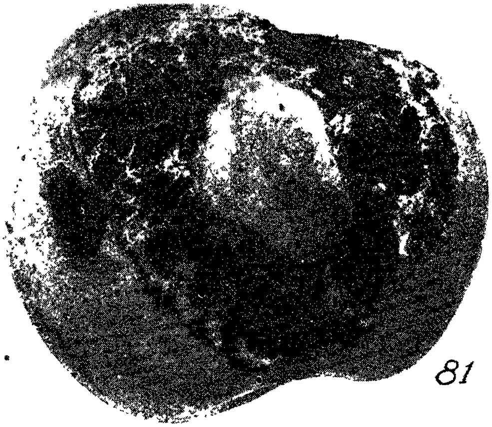
81, Rhode Island *Greening* apple showing a very large and unusual tussock-moth scar, the wound having occurred in mid-July at a time when growth was so slow that brown rot might well have resulted. Photographed on October 21

82, Late tussock-moth work showing excessive feeding on one apple, the injury having occurred in July after the period when the apple was able to heal perfect scars. Photographed on December 18

83, Jonathan apple with tussock-moth scar, showing warting in the mature scar. Photographed on October 31

84, Apple showing a tussock-moth scar (below), and warting produced on a scab spot (above). Photographed on September 1

85, Baldwin apples showing palmer-worm work. The larva that caused the injury may be seen protruding its head from a webbed retreat. Photographed on June 25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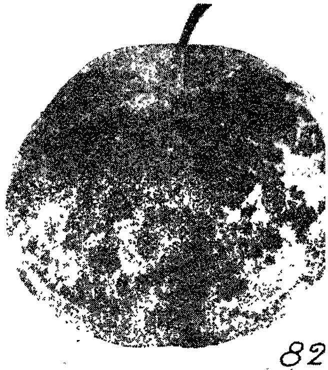
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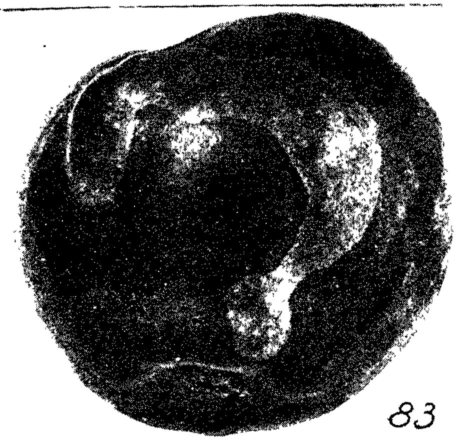
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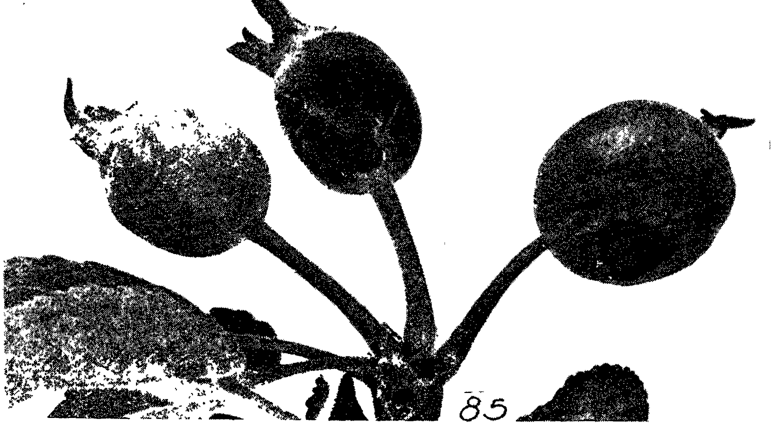
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Plate XXII

INJURIES PRODUCED BY YPSOLOPHUS LIGULELLUS AND BY TMETOCERA OCELLANA

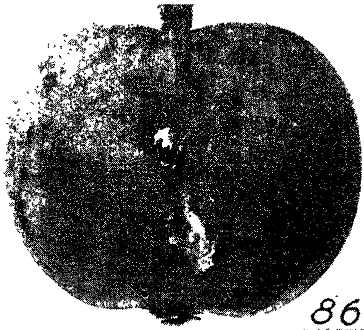
86, Roxbury apple with two small holes made by a palmer worm, showing also some of the web which the larva invariably spins about the cavities it makes. Photographed on July 27

87, Roxbury apple with five small holes made by one palmer worm. The crack showing at either side is the result of growth after the skin of the apple had become hardened. Photographed on July 21

88, Roxbury apples showing scars produced by late feeding of the palmer worm. The apple on the right shows a large and imperfectly healed scar, while the one on the left has a deep cavity where a larva fed for a short time just prior to pupation. Photographed on August 12

89, Pound Sweet apple showing the work of a bud-moth larva just beneath a leaf that was webbed to the side of the fruit. Photographed on September 15

90, A slice from an apple showing where a bud-moth larva had drawn a leaf against the fruit and fed for a short time. Photographed on August 8



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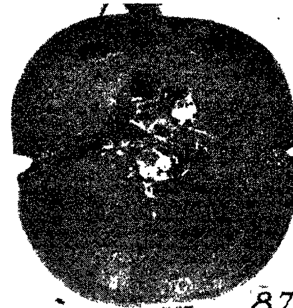

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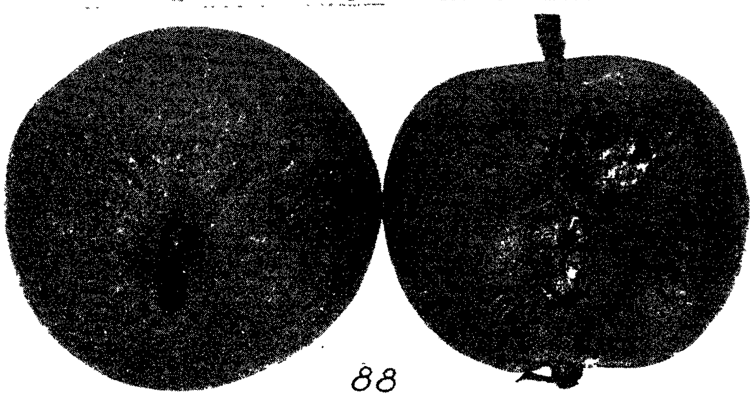

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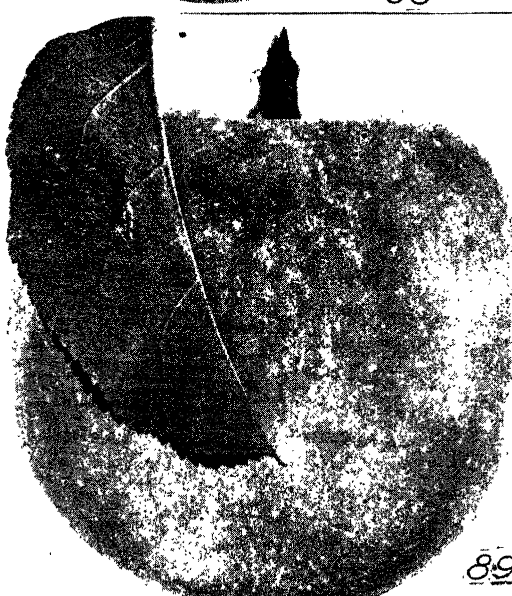

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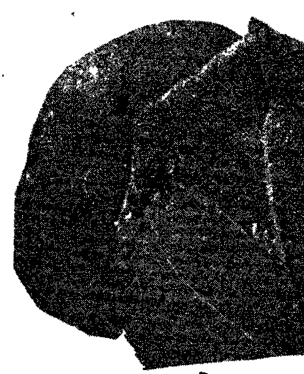

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PLATE XXIII

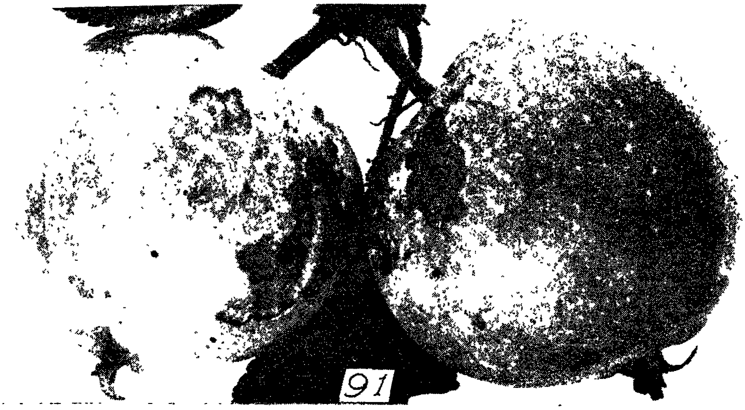
INJURIES PRODUCED BY EULIA VELUTINANA

91, The leaf-roller larva and its work between two Genesee Flower apples. Photographed on July 28

92, The moth spread, enlarged about four times

93, Rhode Island *Greening* apple showing the work of a larva. Photographed on September 21

94, Baldwin apple showing the typical shallow, late-feeding work of the larva, in which little more than the skin of the fruit is eaten. Photographed on September 25



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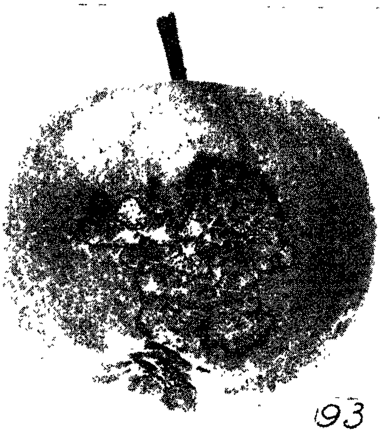

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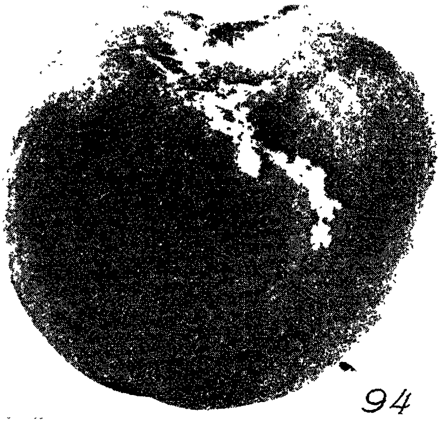

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PLATE XXIV

INJURIES PRODUCED BY COLEOPHORA MALIVORELLA

95, Case-bearers at work on young apples, showing the small round holes that the larvae make in the fruit. Photographed on June 9

96, Twenty Ounce apples exhibiting typical work of the larvae. Some of the larger scars show a small, funnel-shaped depression at the center, indicating that growth had not completely filled the feeding cavity. Photographed on August 30

97, Twenty Ounce apple showing the life work of one larva. The larger scars were made while the apple was growing rapidly, while the smaller scars were made toward the end of the larval feeding period. The "pistol case" may be seen on the twig to which the larva moved for pupation. Photographed on August 30

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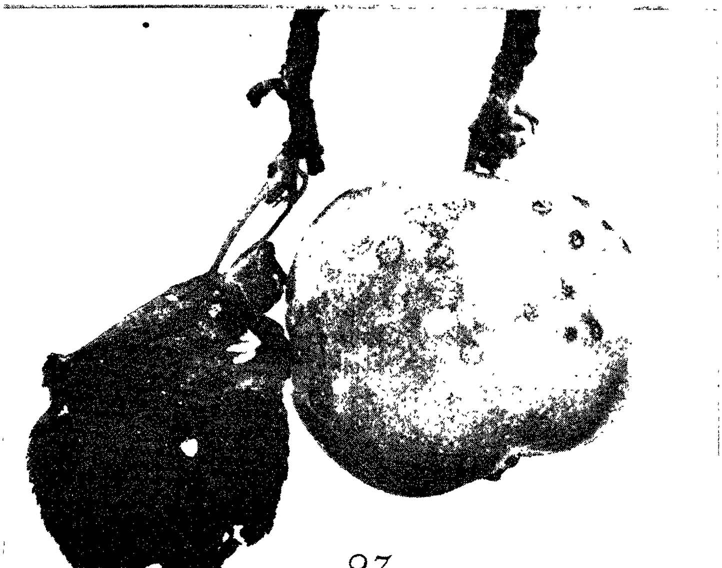

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PLATE XXV

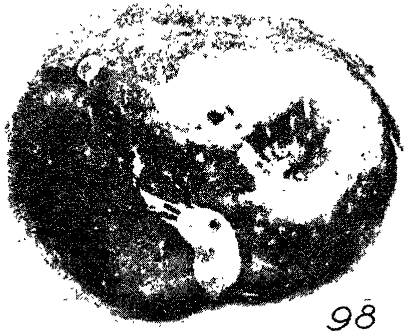
INJURIES PRODUCED BY COLEOPHORA MALIVORELLA AND BY COLEOPHORA FLETCHERELLA

98, Mature scars on Detroit Red apple caused by *Coleophora malivorella*, showing that a splitting and enlargement of the wound has taken place around certain scars. Photographed on October 2

99, Work of *Coleophora malivorella* on a crab apple, showing that some warting occurred on the scars. Photographed on September 27

100, Slices of Baldwin and Twenty Ounce apples which exhibit all types of scars caused by *Coleophora malivorella*. Photographed on September 3

101, *Coleophora fletcherella*, showing the case-bearers at work and the feeding punctures they make. Slightly enlarged. Photographed on May 29



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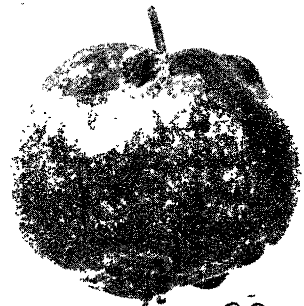

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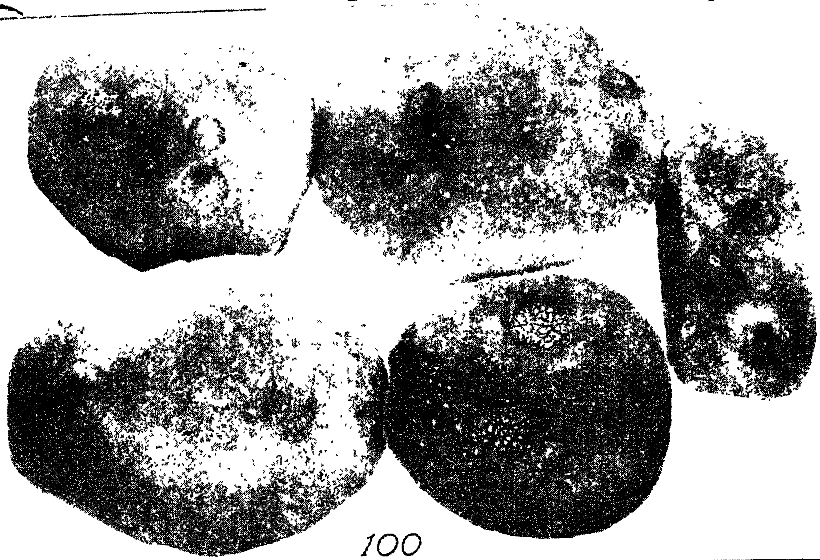

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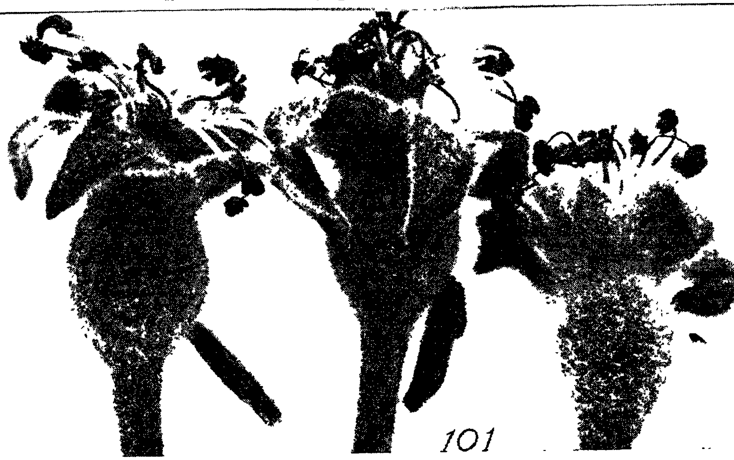

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Plate XXVI

INJURIES PRODUCED BY HYPHANTRIA TEXTOR

102, Alexander apple showing the work of webworms on the fruit, with web and excrement clinging to it. Photographed on July 29

103. Yellow Transparent apple which was fed upon by webworms with the result that it shriveled and dried up. Photographed on August 2

104, Alexander apples on a branch that was inclosed in a webworm nest. The work of the larvae may be seen on the apples. Photographed on July 28

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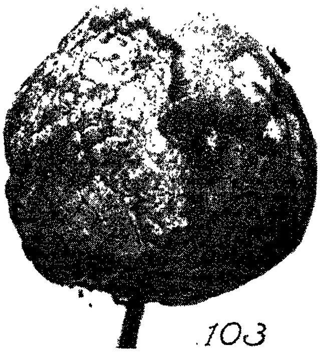

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Plate XXVII

INJURIES PRODUCED BY MARMARA POMONELLA AND BY CONOTRACHELUS NENUPHAR

105, Baldwin apple showing a serpentine mine in the skin of the fruit, produced by *Marmara pomonella*. Photographed on November 10

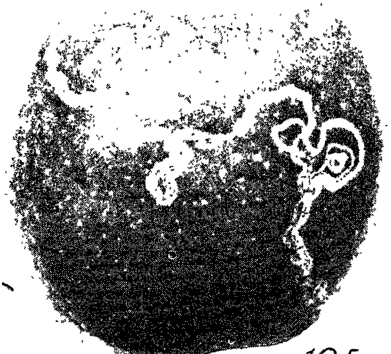
106, Baldwin apple showing a serpentine mine of *Marmara pomonella* which was more or less coiled and formed a blotch. Photographed on November 10

107, A *Conotrachelus nenuphar* curculio resting on a young apple beside a feeding puncture. Enlarged 2½ times. Photographed on May 29

108, A *Conotrachelus nenuphar* curculio resting on a young apple after having made a small feeding puncture, which may be seen just beneath. Enlarged 2½ times. Photographed on May 29

109, Two young apples showing crescents made by the female of *Conotrachelus nenuphar* when laying eggs, and one fruit (at right) showing a typical round feeding puncture. Enlarged 2 times. Photographed on May 29

110, A *Conotrachelus nenuphar* curculio making a feeding puncture in a large apple. Photographed on June 25



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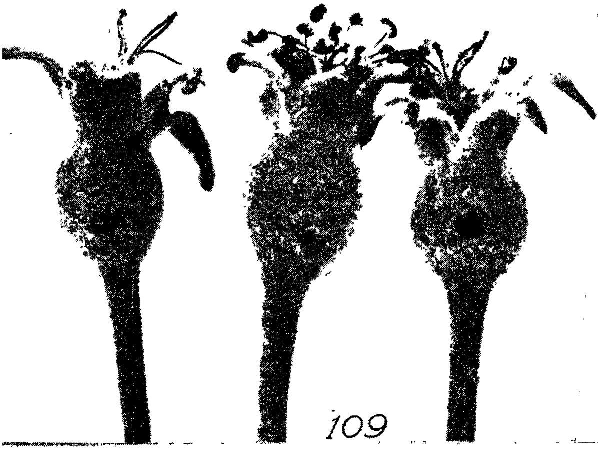

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Plate XXVIII

INJURIES PRODUCED BY CONOTRACHELUS NENUPHAR

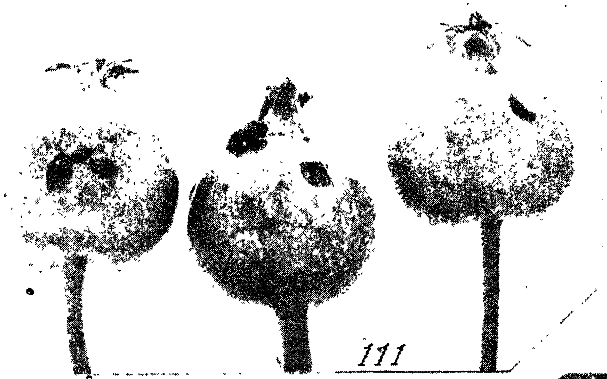
111, Baldwin apples showing egg crescents made by curculios when feeding early in June. Two of the crescents show a white exudation issuing from the egg puncture, indicating that the young grubs are trying to feed. Photographed on June 18

112, Apple in section, showing the burrow of a curculio larva leading from the egg puncture toward the core. This fruit was picked from the tree just before the photograph was made, on July 13

113, Injuries on a Rhode Island *Greening* apple with which a female curculio was caged from June 29 to July 6. Photographed on July 21

114, Twenty Ounce apple showing several egg-crescent scars. Some of these resemble case-bearer work, but the egg-puncture mark which is discernible on all but one scar indicates that the plum curculio made the wounds Photographed on September 9

115, Red Astrachan apple showing both the crescents made by the plum curculio, and the irregular, splitting scars resulting from punctures of *Lygidea mendax*. Photographed on July 8



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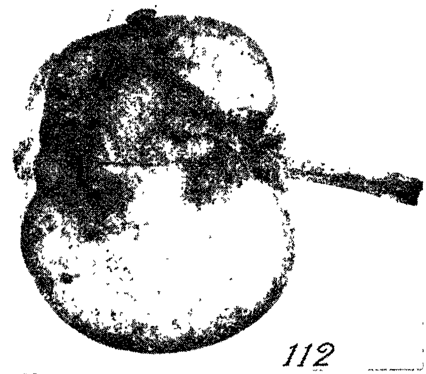

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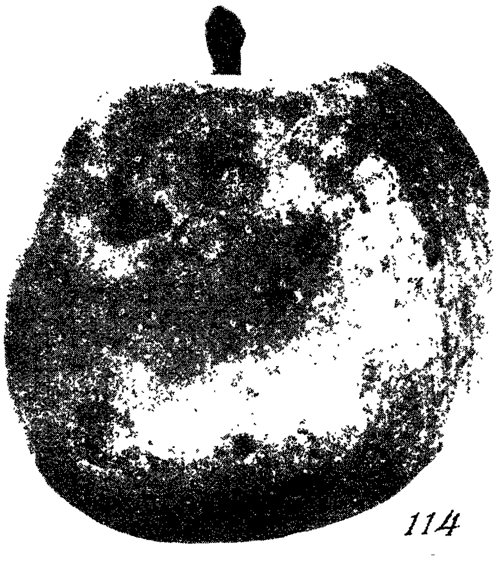

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Plate XXIX

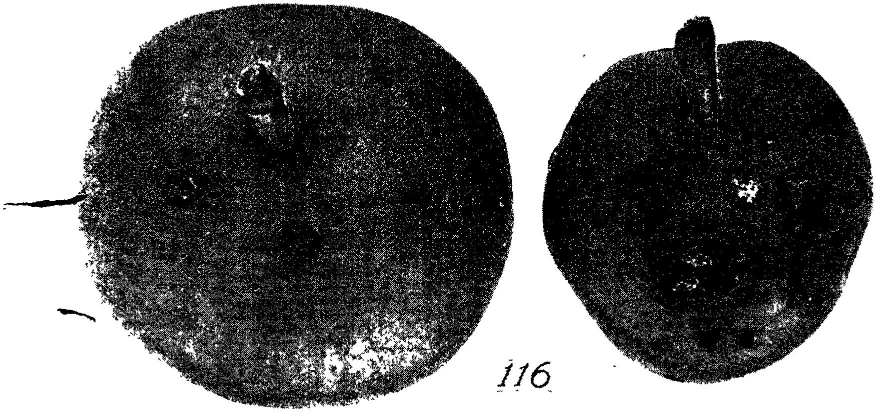
INJURIES PRODUCED BY CONOTRACHELUS NENUPHAR

116, Curculio injury on two Roxbury apples, produced during the last few days of July and the first week of August. The fruits show feeding punctures as well as egg crescents. Several of the punctures are surrounded with brown rot. Photographed on August 8

117, Slices from apples showing egg-crescent scars which are perfectly formed but some of which are much less distinct than are others. Photographed on November 29

118, Northern Spy apple showing the irregular scars produced by *Lygidea mendax*, which may be distinguished from the scars with uniform margins that usually result from curculio punctures. Photographed on September 15

119, Jonathan apple showing curculio scars bulging out or warting beyond the normal surface of the fruit. Photographed on October 31



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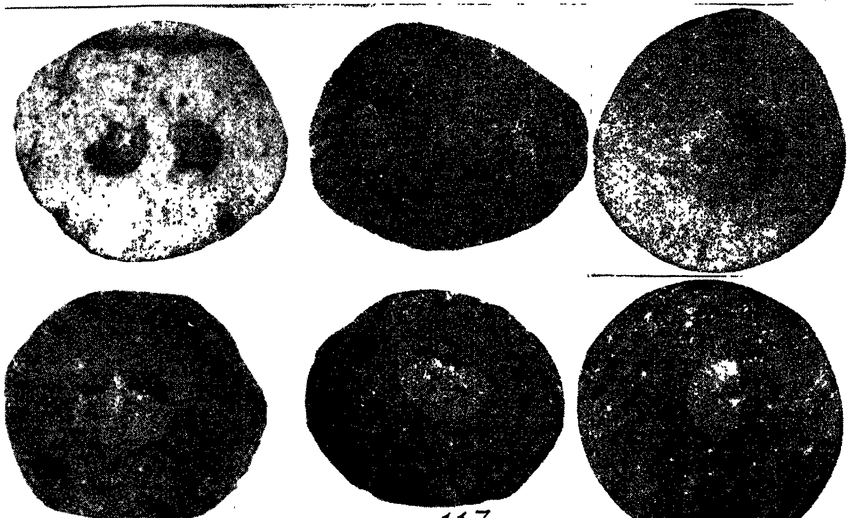

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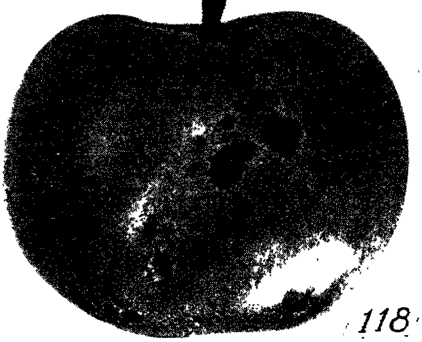

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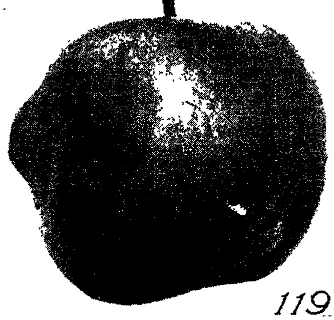

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Plate XXX

INJURIES PRODUCED BY CONOTRACHELUS NENUPHAR AND BY ANTHONOMUS QUADRIGIBBUS

120, Rhode Island *Greening* apple on which curculio scars were enlarged by muscid flies, the flies feeding on the brown rot as it formed in the wounds. Photographed on August 22

121, Rhode Island *Greening* apple (at left) and Maiden Blush apple (at right) cut in section to show the extent of the cavities formed where flies had enlarged the wounds made by *Conotrachelus nenuphar*. Photographed on August 22

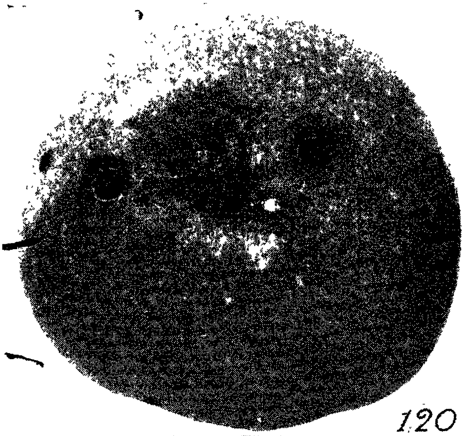
122, An *Anthonomus quadrigibbus* curculio on the side of a young apple. Enlarged 2½ times. Photographed on May 29

123, A female of *Anthonomus quadrigibbus* ovipositing in a young apple while a second beetle rests on the calyx above. Photographed on May 28

124, Two *Anthonomus quadrigibbus* curculios resting on a young apple after one has laid an egg. Photographed on May 28

125, Baldwin fruits which were so severely injured by *Anthonomus quadrigibbus* between June 25 and June 30 that they dropped. Photographed on July 7

126, Baldwin apple cut in section to show the egg and feeding cavities made by *Anthonomus quadrigibbus.* Photographed on July 5



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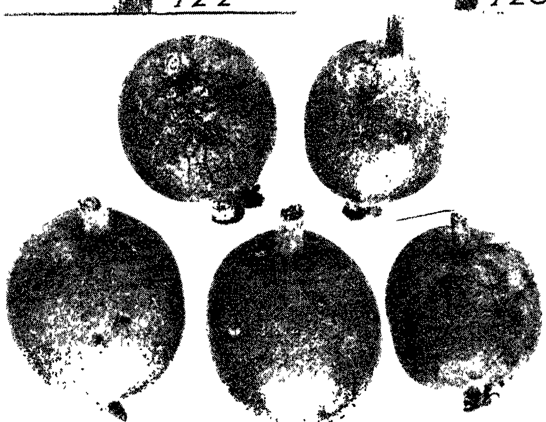

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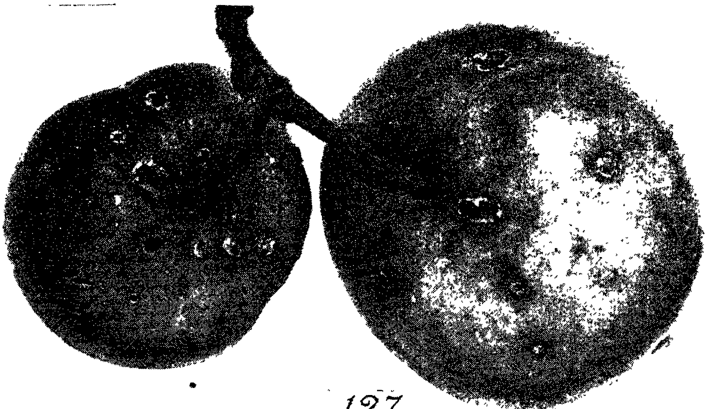
PLATE XXXI

INJURIES PRODUCED BY ANTHONOMUS QUADRIGIBBUS

127. Baldwin apples showing the scars produced by a pair of curculios which were caged on the fruit from June 16 to July 6. Natural size. Photographed on October 21

128. Stark apples which recovered from egg punctures made by an apple curculio near the end of June. Photographed on September 5

129. Bartlett pears showing the egg and feeding punctures produced by a pair of apple curculios in the first week of July. The punctures all became filled with a hard, granular substance during subsequent growth. Photographed on September 9



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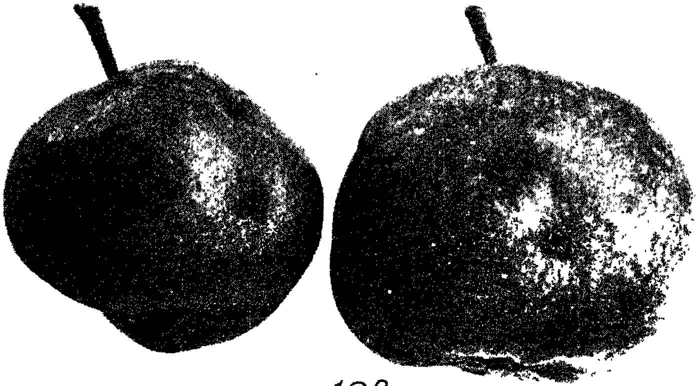

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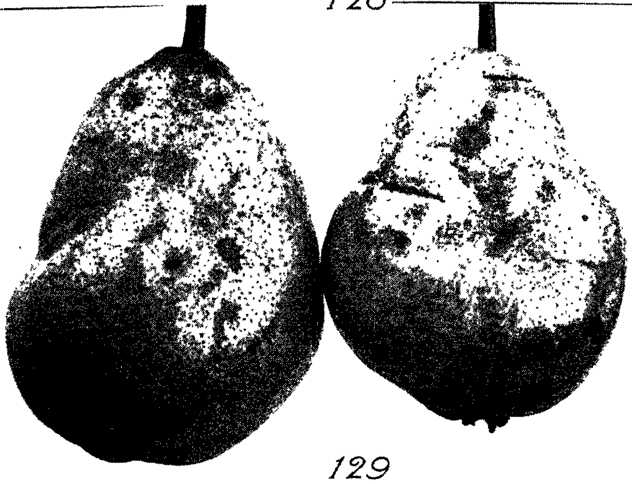

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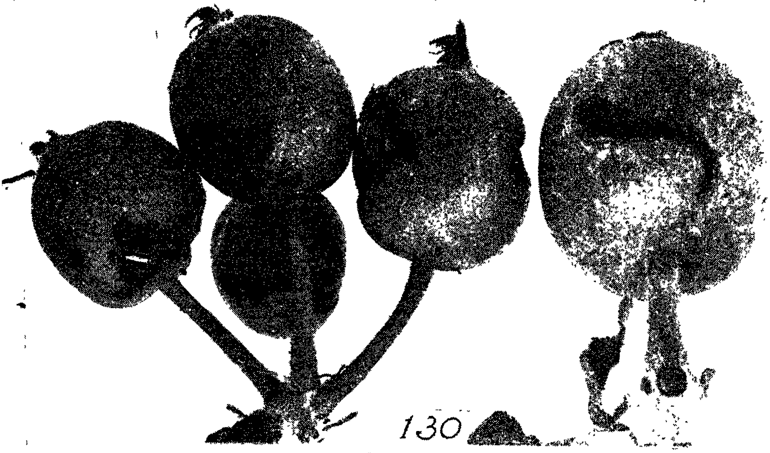
Plate XXXII

INJURIES PRODUCED BY MACRODACTYLUS SUBSPINOSUS

130, Baldwin apples showing the deep, irregular wounds produced by feeding rose chafers. Photographed on July 3

131, Baldwin and Tompkins King apples which show typical injuries caused by feeding rose chafers at the end of June. Photographed on July 3

132, Apples injured by rose chafers and found to have developed brown rot. All of these fruits shriveled and fell from the tree within two or three weeks after the injury occurred. Photographed on July 14



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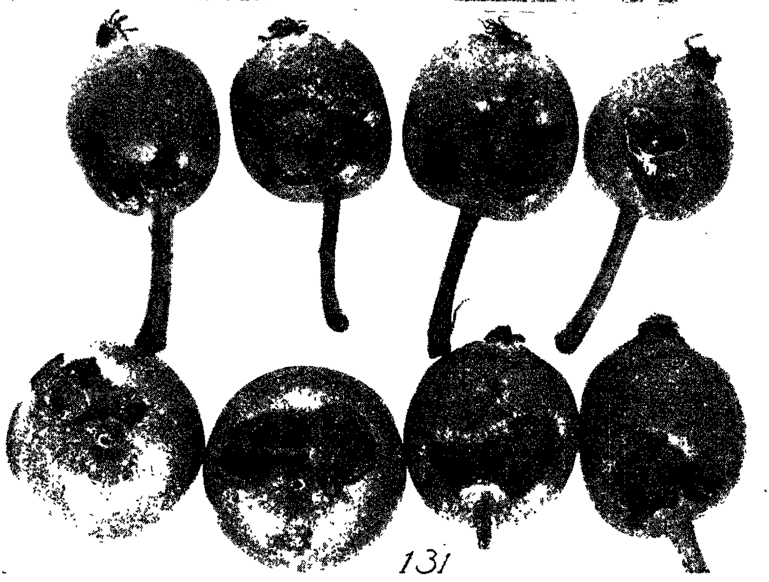

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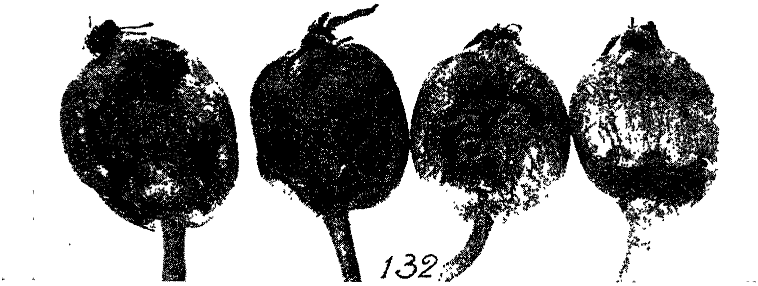

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PLATE XXXIII

INJURIES PRODUCED BY RHAGOLETIS POMONELLA

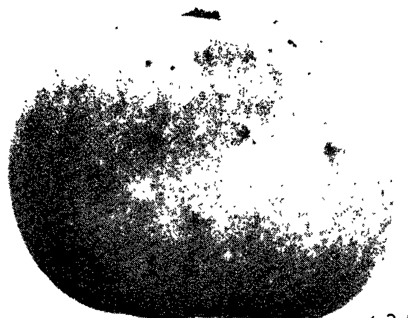
133, A female apple-maggot fly in position for ovipositing in a crab apple. Photographed on September 5

134, Maiden Blush apple showing several oviposition marks. Photographed on August 23

135, Maiden Blush apple cut in section to show the work of the maggots within, also (at right) the emergence holes of the mature maggots. Photographed on September 5

136, Maiden Blush apple in section, showing two mature maggots in the brown-rot areas and also the tunnels made by other maggots in the flesh of the fruit. Photographed on October 31

133



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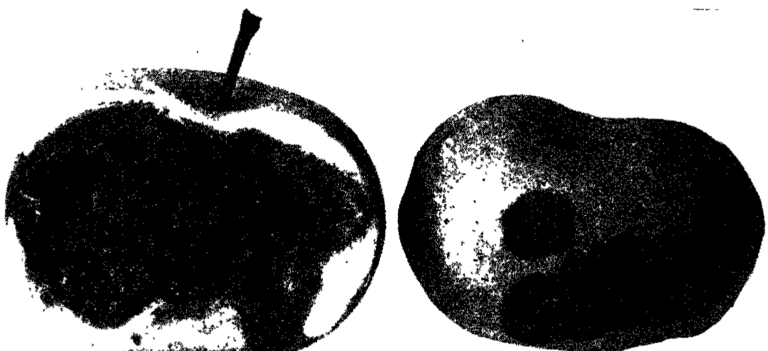

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Plate XXXIV

INJURIES PRODUCED BY RHAGOLETIS POMONELLA, THE BLACK ROT FUNGUS, AND SYNTOMASPIS DRUPARUM

137, Tompkins King apple showing the emergence holes of two apple maggots. One of these scars represents the extent to which brown rot developed during the four days following the exit of the maggot. Photographed on October 7

138, Crab apples showing the small dimples caused by the ovipositor of the chalcis fly, *Syntomaspis druparum*. Photographed on August 1

139, Tompkins King apple showing the emergence holes of apple maggots and the development of brown rot at the surface about the exit holes. Photographed on November 29

140, Baldwin apple showing numerous oviposition marks made by the apple-maggot fly. Each puncture appears somewhat enlarged and is surrounded by a dark green color, a condition caused by the black rot fungus (*Physalospora Cydoniae*) and the New England fruit spot (*Phoma pomi*), which were probably being introduced as an infection on the ovipositor of the fly. Photographed on October 28

141, Crab apples infested with the apple maggot. The lower apples show the dark tunnels of the maggots, which may be seen through the skin of the fruit. The apples in section show the extent of the tunnels and the development of brown rot. Photographed on September 21

142, Crab apples cut in section to show the dark trails left by the ovipositor of the female of *Syntomaspis druparum*. These scars may be seen leading from the surface of the fruit to the seeds. Photographed on August 1

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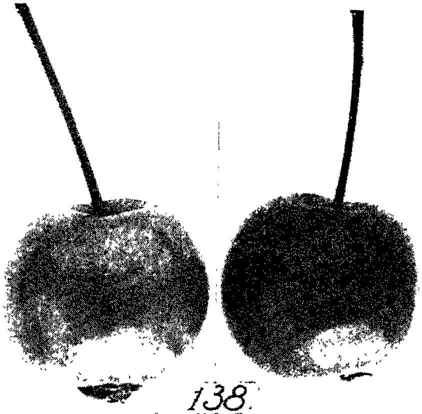

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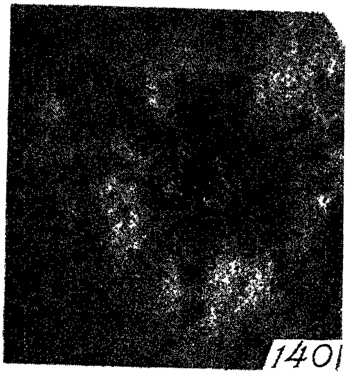

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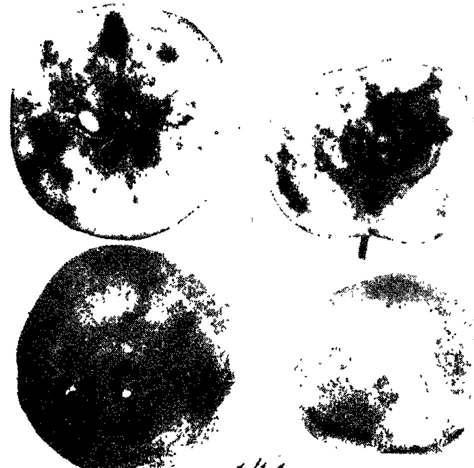

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Plate XXXV

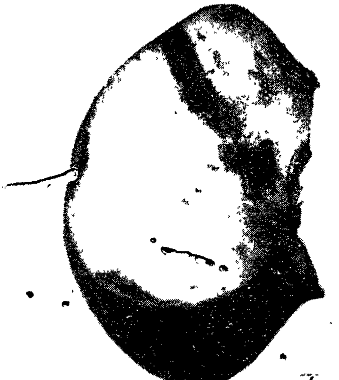
AMETASTEGIA GLABRATA, AND THE WARTING OF SCARS CAUSED BY VARIOUS INSECTS

143, Section through an apple, showing the larva of *Ametastegia glabrata* in its hibernating cell. Photographed on October 28

144, Tolman apple with russet scars caused by *Lygidea mendax*, showing a slight warting of the scars. Photographed on September 18

145, Rhode Island *Greening* apples showing russet scars caused by *Lygidea mendax*. These apples underwent forced growth during August, causing a warting of the scars. Photographed on December 14

146, Ben Davis apples showing unusual warting or the scars made by tussock-moth larvae. Photographed on December 4



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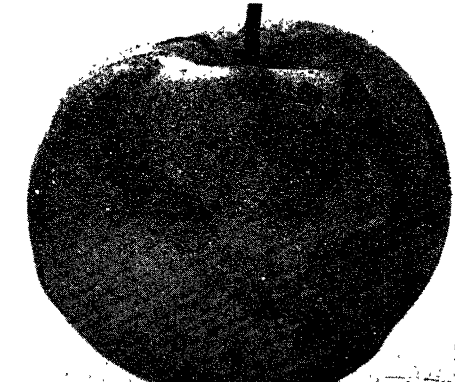

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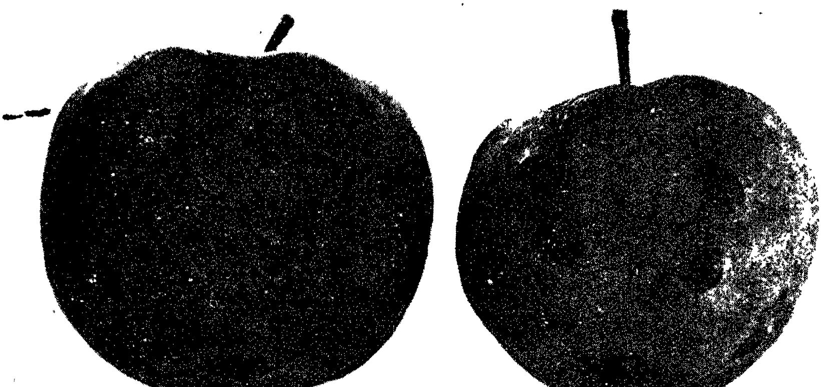

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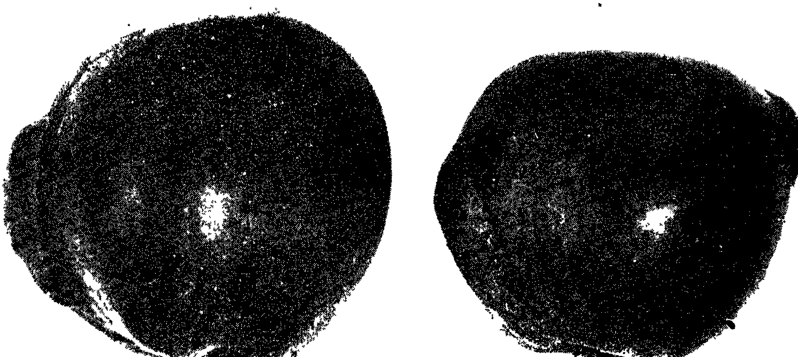

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Plate XXXVI

MECHANICAL INJURIES, PIN PUNCTURES, AND CRACKING FRUIT

147, Rhode Island *Greening* apple which was rubbed constantly by a limb just beneath, from the time it was an inch in diameter until picking time. Photographed on October 23

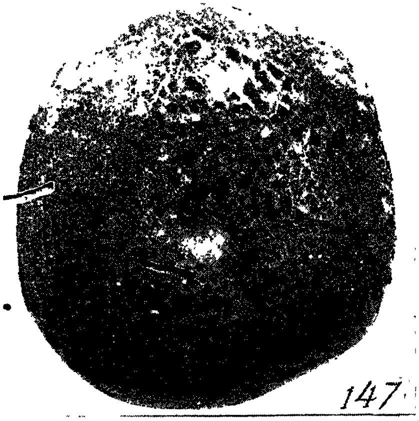
148, Baldwin apple which during its development was blown frequently against a sharp stub. Photographed on September 25

149, Rhode Island *Greening* apple which had small holes punched through the skin by a very sharp stub. Photographed on September 15

150, Baldwin apple showing the russet surface developed due to its rubbing against a stub from the time it was one-half inch in diameter until it had grown to be one and one-half inches in diameter, when the obstruction was removed. Photographed on October 23

151, Mature scars on a Rhode Island *Greening* apple, produced by puncturing the young fruit on June 25 with a No. 0 insect pin. Photographed on September 25

152, Roxbury apple showing large, deep cracks. Photographed on August 14



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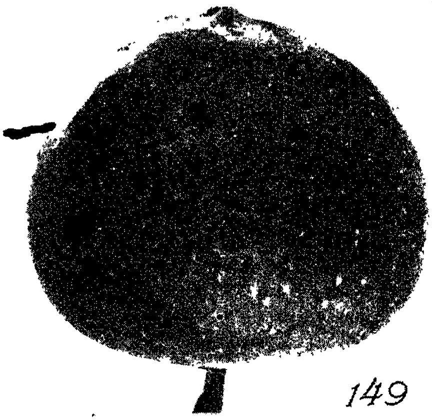

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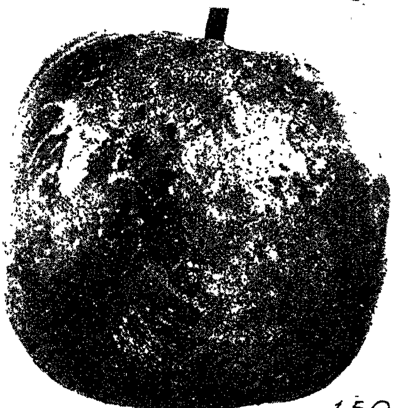

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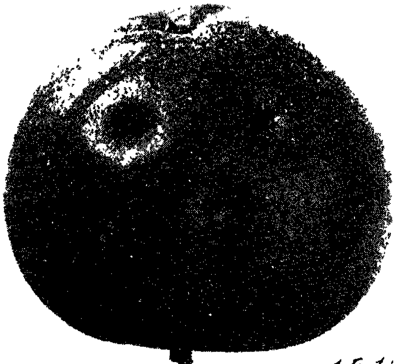

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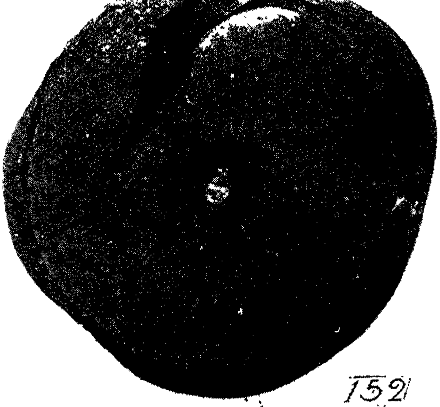

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Plate XXXVII

CRACKING FRUIT, AND LIME-SULFUR SPRAY INJURY

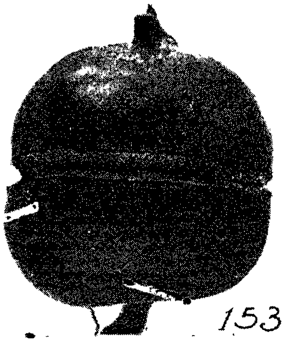
153, Roxbury apple completely circumscribed by a large crack. Photographed on July 21

154, Rhode Island *Greening* apples showing deep cracks which probably had their origin in the russet scars caused by redbugs. Photographed on August 17

155, Rhode Island *Greening* apple which developed large cracks over the surface, covered by the broad russet type of redbug scars. Photographed on August 30

156, Baldwin apple which was drenched with commercial lime-sulfur at the time of the calyx spray. Photographed on September 9

157, Apples from one limb of a Baldwin tree which always bore fruit having a russet skin and developing large, deep cracks. Photographed on August 22



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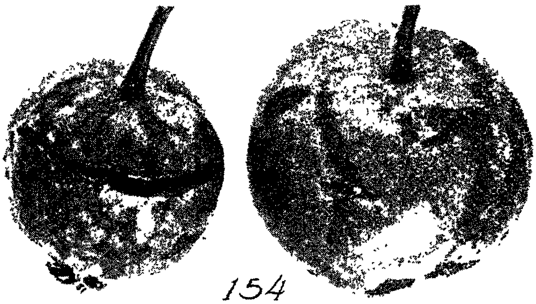

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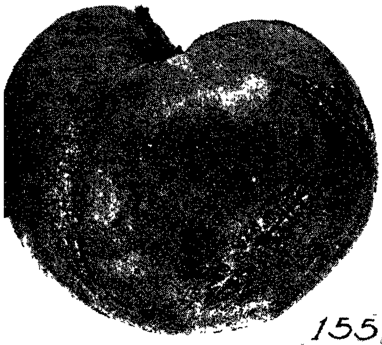

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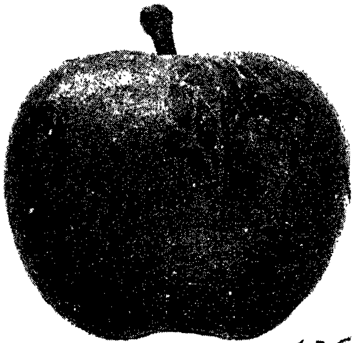

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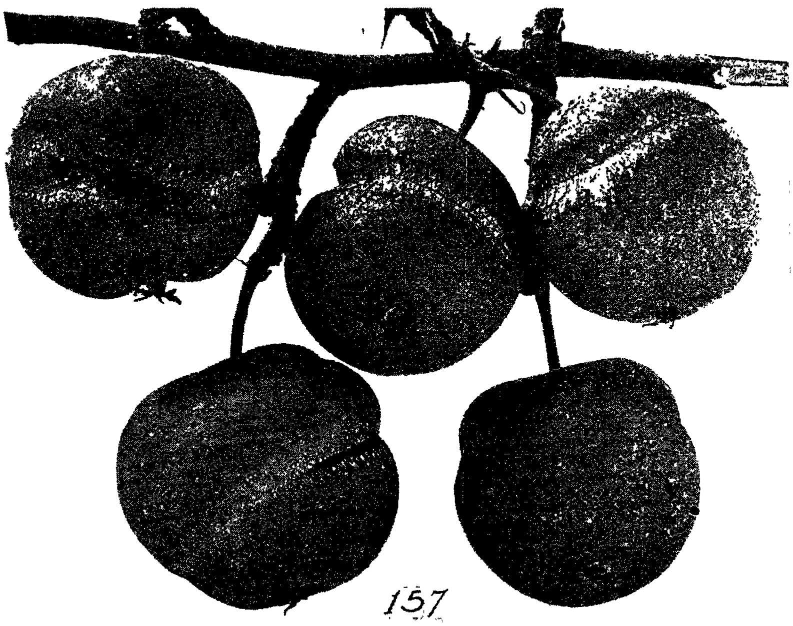

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Plate XXXVIII

LIME-SULFUR SPRAY INJURY, SUN-SCALD, AND FROST INJURY

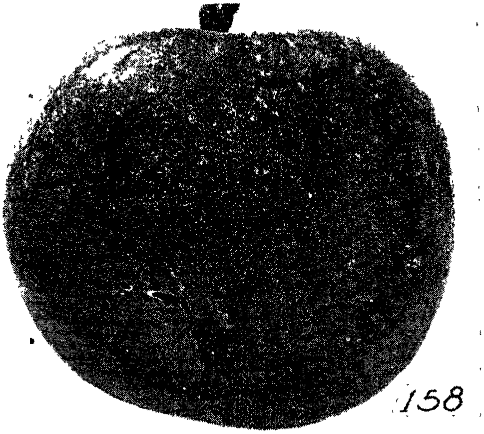
158, Tompkins King apple which was drenched with lime-sulfur spray (1 to 40) at the time of the calyx spray, that being the last time the tree was sprayed. Photographed on August 14

159, Sun-scald. Baldwin apple cut in section, the scalded tissue showing dark near the surface of the fruit. Photographed on August 16

160, Rhode Island *Greening* apples covered with spray material, which show dark on one side as a result of sun-scald. Photographed on August 16

161, Baldwin apple which developed sun-scald on August 5, as it appeared at picking time. The scalded tissue first turned brown, and then dried out and developed cracks as shown. Photographed on October 21

162, Young apples showing scars which gave the first signs of frost injury following the frost of May 28. Photographed on June 18



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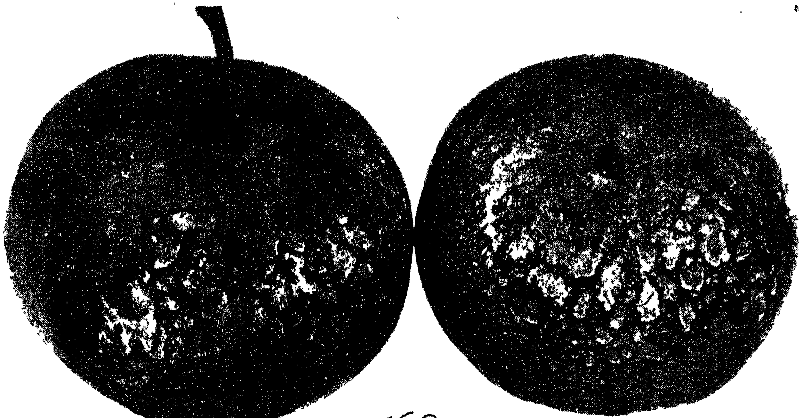

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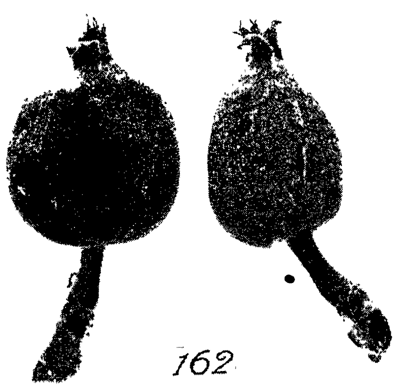

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Plate XXXIX

FROST INJURY

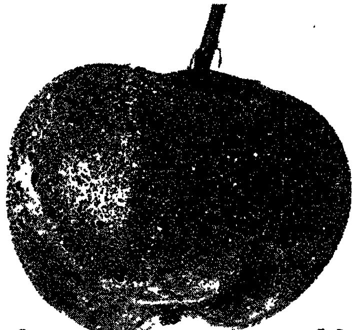
163, Northern Spy apple showing severe frost injury. This was picked in an orchard where nearly all of the fruit was killed by frost. Photographed on August 26

164, Genesee Flower apple showing a frost band about its circumference and one crack along the axis Photographed on August 23

165, Large frost bands on two Genesee Flower apples. Photographed on August 17

166, Red Astrachan apples showing prominent frost bands. Photographed on August 21

167, Baldwin apples showing frost injury at the calyx end only. Photographed on August 1



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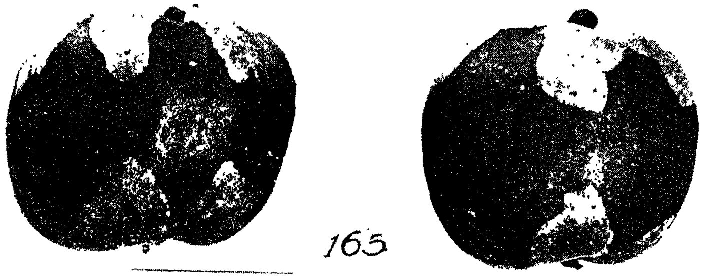

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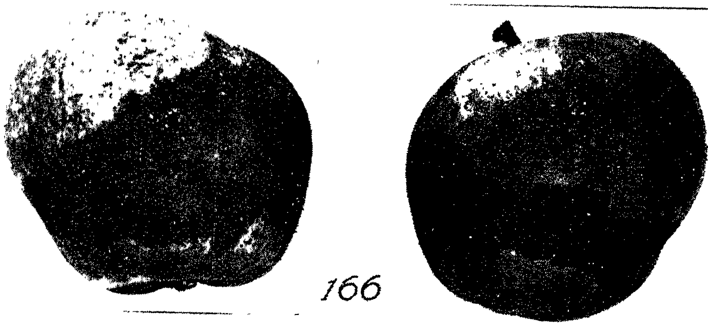

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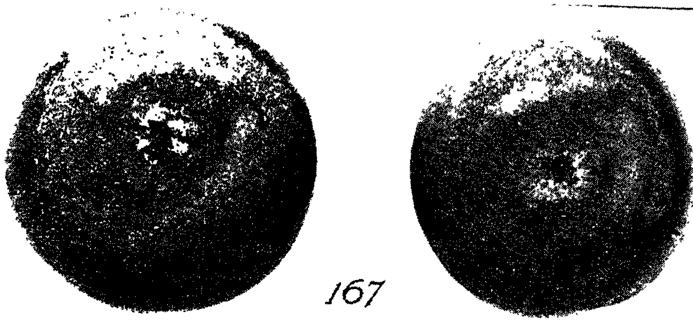

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Plate XL

FROST INJURY AND HAILSTONE INJURY

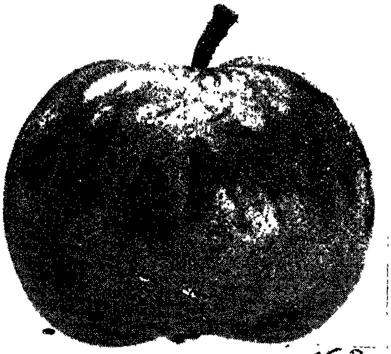
168, Maiden Blush apple showing the frost band broken into segments, also a slight warting of the scars. Photographed on September 7

169, Rhode Island *Greening* apple with scars that represent severe freezing of the young fruit. Photographed on September 9

170, Golden Russet apples showing cracks and excess russeting due to frost injury Photographed on August 1

171, Northern Spy apples broadly marked with russet on the basal half, due to frost injury. Photographed on August 1

172, Sections of apples taken immediately beneath hailstone spots such as are shown in Plate XLI, 173. Photographed on August 4



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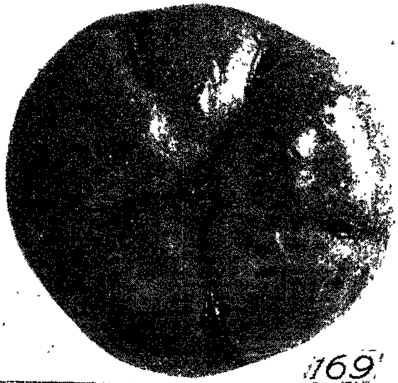

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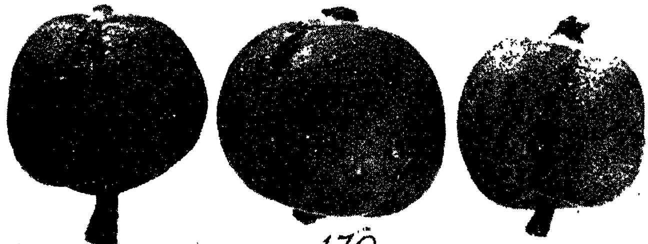

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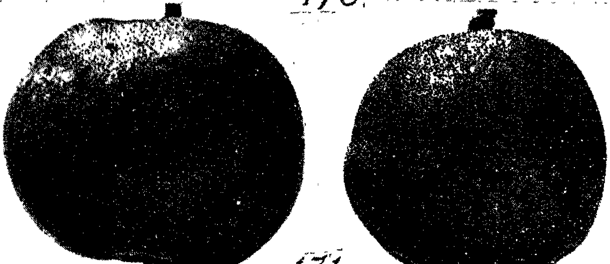

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Plate XLI

HAILSTONE INJURY

173, A Baldwin apple, injured by hailstones on July 20, as it appeared on August 4

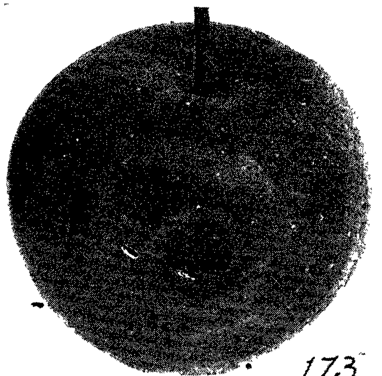
174, A Baldwin apple which was injured by a large angular hailstone on July 20, as it appeared on August 4

175, A Baldwin apple which was badly injured by a hailstone on July 20, showing the stage of recovery that it had reached on August 17

176, An apple showing four hailstone injuries that were inflicted early in July, and one small fruit-worm scar (in center) which very much resembles them. Photographed on August 23

177, Crab apples showing several hailstone scars. Photographed on August 17

178, Baldwin apples that received several hailstone pecks, shown to be recovering when photographed on August 17



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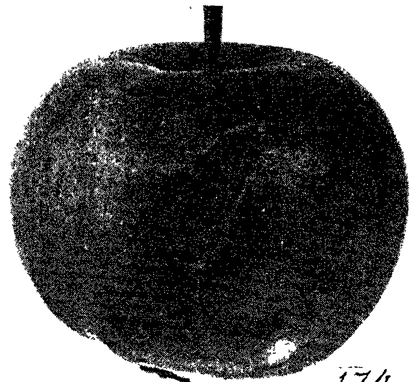

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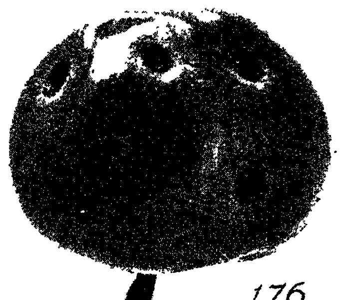

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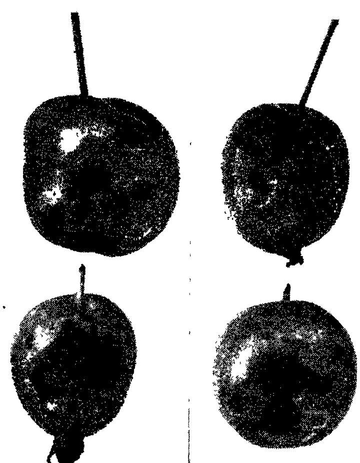

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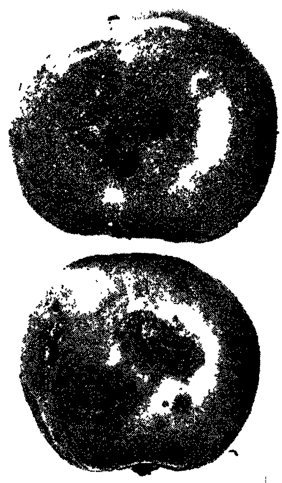

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Plate XLII

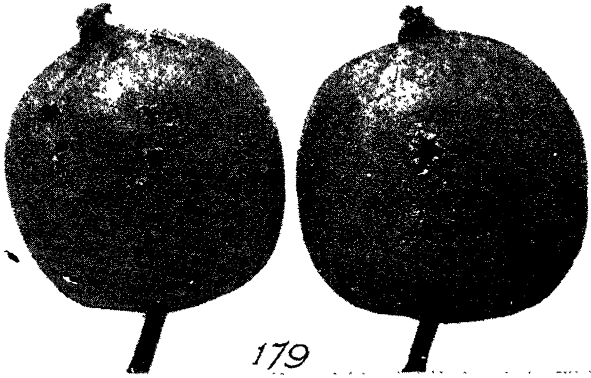
INJURIES PRODUCED BY APPLE SCAB AND STIPPEN

179, Scab spots on Rhode Island *Greening* apples, showing the papery edge which surrounds the dark central spot. Photographed on July 20

180, Excessive scab development on one side of a Rhode Island *Greening* apple. The scab caused the skin to dry out and harden, with the result that a large crack developed. Photographed on July 20

181, Rhode Island *Greening* apple showing the spots caused by late scab infection. Photographed on September 15

182, Baldwin apple in section, showing dark discolorations in the flesh where stippen has developed. Photographed on August 22



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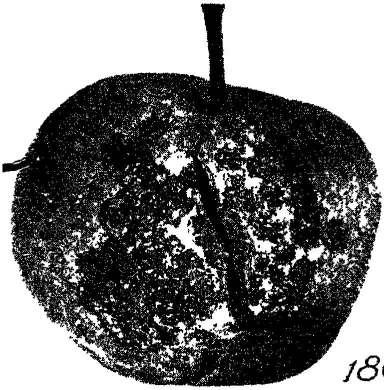

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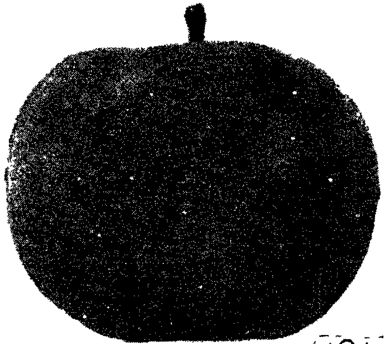

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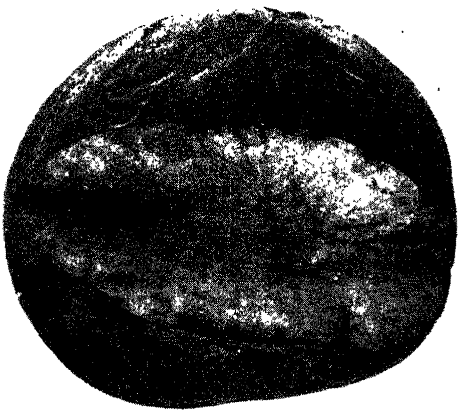

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July/1922

Bulletin 411

The Clover-Leaf Weevil

Glenn W. Herrick and C. H. Hadley, Jr.

WORK OF LARVAE OF CLOVER-LEAF WEEVIL

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THE CLOVER-LEAF WEEVIL

Hypera punctata Fab.

GLENN W. HERRICK AND C. H. HADLEY, JR.

The clover-leaf weevil, a European insect, was first noted as injurious in this country in 1881, in Yates County, New York, near Barrington. The records seem to indicate that a single specimen of this weevil was collected in Canada as long ago as 1853. If that is true, the insect did not attract attention as an injurious species until nearly thirty years thereafter, when it was suddenly found in a clover field in New York in exceeding abundance and causing serious injury. It has spread gradually westward to Iowa and even to the Pacific Coast, and has worked southward at least as far as North Carolina, Tennessee, Mississippi, and Texas. It seems to have had no difficulty in meeting the varying climatic conditions existing over so large an area, but has thriven, and has become, at times, noticeably injurious in widely separated regions. It is quite probable that the weevil in its original habitat in Europe and northern Asia finds as much variation in climatic conditions as it does in America.

FOOD PLANTS

In Europe the weevil has been reported as feeding on alfalfa (*Medicago sativa*), red clover (*Trifolium pratense*), crimson clover (*T. incarnatum*), and Jerusalem artichoke (*Helianthus tuberosus*). In this country it feeds on red clover, white clover, mammoth clover, sweet clover, alsike, and alfalfa. The larvae and the adults have been observed feeding on beans, and the adults have been seen eating also the leaves of corn, timothy, burdock, and soybean, and the flowers of goldenrod. In New York the authors have found the species most injurious to red clover.

FEEDING HABITS AND INJURIES

Both the adults and the larvae feed on the plants. The larva, while young, eats small areas of tissue from the under side of the foliage, thereby making small, round holes throughout the leaf. Later, as the larva becomes larger, it eats large, irregular notches out of the leaf, thus giving a ragged appearance to the foliage. The larvae become active in the late afternoon and feed mostly then and during the dusk of early evening. During the day they may be found curled up in an inactive condition at the bases of the plants, sometimes hidden beneath débris.

The adult beetles are very ravenous and feed voraciously on the leaves, the leaf stems, and the main stems of the plant. At times they may devour nearly all of a plant above ground. They attack the leaves from

the margins, eating out large notches along the edges. Often they attack the main stems and eat so much of the tissue that the ends droop over. The adults also lie quiescent during the day, remaining hidden at the bases of the plants until late afternoon and evening, when they become active and do their feeding.

In its natural habitat in Europe, the clover-leaf weevil is only intermittently injurious enough to receive attention. There seem to be but few occasions recorded when it has become serious enough to demand investigation. Perhaps the most notable instance was an outbreak in northern Italy in 1868, which became so serious that a commission was appointed to investigate the injury and several papers were published regarding it. Again in 1879 a severe outbreak occurred in the territory around Florence, and in 1902-03 the weevil was again injurious in the same region.

As already mentioned, the first outbreak noted in the United States was in 1881 in Yates County, New York. Here C. V. Riley found the species in great abundance, and he says that acres of clover had been ruined by the larvae and beetles devouring the foliage. Later investigations showed that the insect was present over a large area in the county, and that wherever it was present it had caused much damage. Other outbreaks have been recorded, notably in Michigan; but in no instance has the period of injury been a long one, nor has it long remained unchecked by natural agencies, as is shown later.

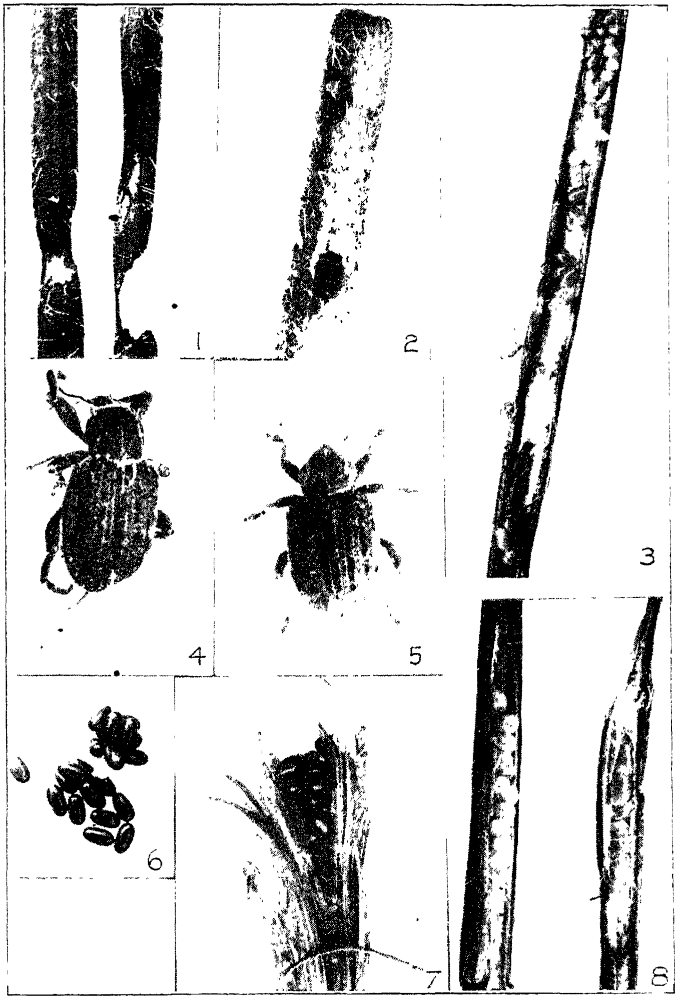
The most serious outbreak coming under the observation of the authors occurred in New York State during the spring of 1919. On a farm near Warsaw, in a field of eight acres of clover sown the year before to wheat, the larvae occurred in enormous numbers and for a time devoured the clover as fast as it grew. On May 17 the senior author visited the field and found the larvae in all stages of growth, many being nearly full-grown. To the uninitiated the field seemed doomed to destruction. From six to eight grubs were present at the base of each plant. But the most striking thing about them at this time was the large numbers of individuals that were dead or dying from the attacks of the fungus *Empusa sphaerosperma*.

The weevil and its larvae are present every year in greater or less numbers in fields of clover in New York, and must always cause considerable injury to the hay crop. It can hardly be looked upon as a pest of first importance; yet it is persistent and always destructive, and the aggregate toll that it takes from the farmer is undoubtedly larger than is realized.

LIFE HISTORY AND HABITS

The egg

The egg is a conspicuous yellow object, elongate-oval and slightly over 1 millimeter long and from 0.5 to 0.6 millimeter wide. When first



THE CLOVER-LEAF WEEVIL

1, Stems eaten by adults. 2, Stem with feeding cavity below and egg above. 3, Stem cut open to show mass of eggs. 4, Weevil killed by fungus. 5, Weevil. 6, Eggs. 7, Mass of eggs in end of old root. 8, Eggs placed in stems. (All enlarged)

laid, it is light glistening yellow, but it soon turns darker, becoming olive green and finally dark brown. The beetle deposits the eggs in old hollow clover stems, in cavities made in fresh stems, and often in masses on the outside of the stems and leaves and even in the frayed ends of old roots (Plate I). The eggs are laid mostly in the fall, from the latter part of August to the latter part of November and probably later in open weather. The following records show the variation in the number of eggs deposited by different females and the periods over which egg deposition may extend. The beetles were kept in pairs in jelly tumblers, and were fed with fresh material every day.

Pair no.	Period of deposition	Number of eggs
104	October 6 to November 10	80
105	September 4 to November 10	335
108	September 28 to November 1	48
109	October 7 to November 10	98
117	October 5 to November 20	69
118	September 14 to November 11	178
120	September 9 to December 3	76
123	September 2 to November 11	196
127	September 21 to October 12	106
128	September 2 to October 24	334
130	August 22 to November 11	445
133	August 25 to November 20	182

Many more pairs of beetles were maintained in this way and extensive records were obtained, but the data given are probably sufficient to show the average facts. It will be seen that the longest egg-laying period extended from August 25 to November 20, a total of 87 days, while the greatest number of eggs deposited by one female was 445. This number, however, was exceeded by one female which laid from September 9 to October 29, inclusive, a total of 473 eggs.

The earliest record for the deposition of eggs was on August 22, and the latest was on November 20. The greatest activity in egg-laying was, on the whole, during the month of September, although many beetles continued actively to deposit eggs through October. The accompanying table (facing page 8) serves to show the activities of the beetles in laying their eggs during the months of September and October. Few eggs were deposited in November.

It has been found (Herrick, 1920) that in certain seasons, at least, eggs may be laid in the spring either by overwintering beetles or by those that have emerged from pupae formed during open warm spells of the season. For example, in the spring of 1919 numbers of fresh active adults were found in clover fields. These were placed in cages, and in a few days they began depositing eggs. On April 7 a group of seven fresh

eggs was found in a hollow clover stem. On April 19 a batch of nine or ten eggs was found, and on April 21 another group of nine eggs was found in a hollow stem. In all, four or five batches of eggs were obtained from these beetles. It is likely that eggs were deposited in the open fields during the spring of 1919, for certainly fresh active beetles were present in considerable numbers.

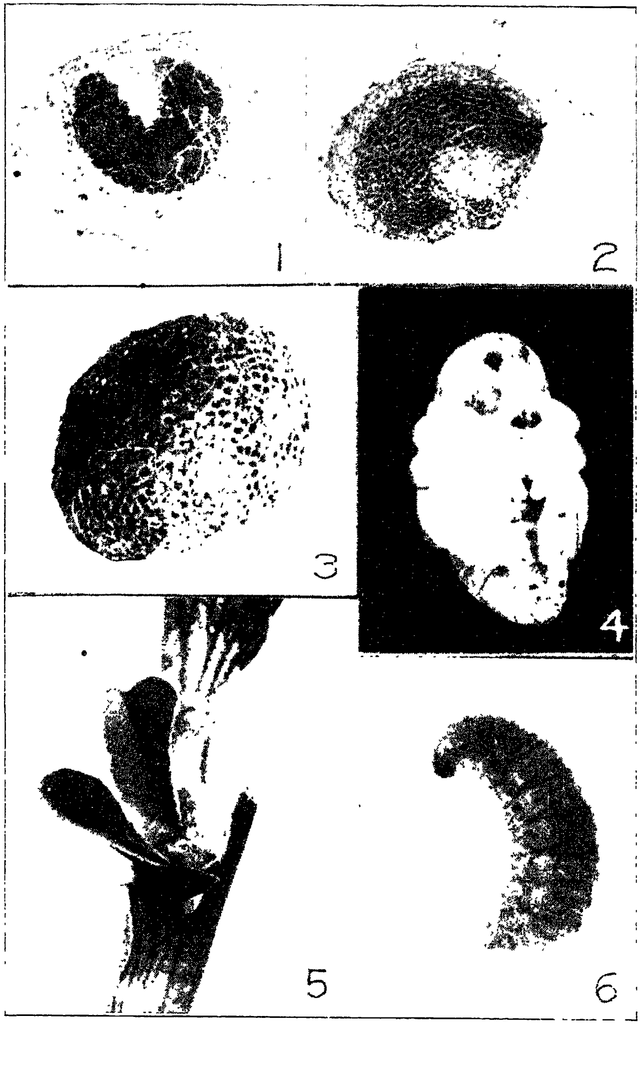
The incubation period varies greatly, as the following examples from the authors' many records show. The figures are for 1915-16.

Date eggs were laid	Number laid	Date of hatching	Number hatching	Period of incubation (days)
September 4	26	September 19	21	15
September 10	26	October 7	16	27
September 7	22	September 19	2	12
September 9	16	September 27	6	18
September 7	16	September 20	5	13
September 4	15	September 20	4	16
September 14	15	October 23	7	39
September 13	23	October 23	23	40
September 10	37	October 7	24	27
September 12	13	October 7	5	25
September 12	13	October 11	4	29
September 10	22	October 6	20	26
September 13	12	October 14	3	31
September 13	12	October 16	7	33
September 15	55	November 4	55	50
September 25	16	April 13	2	201
September 24	23	April 11	23	200
September 24	6	April 12	6	201
September 30	5	April 11	3	194
September 24	20	April 13	8	202
September 28	30	April 12	6	197

It would appear, in general, that eggs deposited during the last week of September and the month of October, in the fall of 1915 at least, went through the winter without hatching. This is a somewhat earlier period for the eggs to stop hatching than would ordinarily be expected, and probably would not hold for all seasons. Considerable variation in this respect, correlated with the temperature and seasonal conditions, may be expected. In all cases observed, the embryos of the overwintering eggs were well developed the previous fall but in many instances when the eggs hatched in the spring the larvae failed to survive.

The larva

Excellent descriptions of the different stages of the larva have been given by Tower and Fenton (1920) and need not be repeated here. The larva, when grown, is normally green in color, although it may have a yellowish or a pinkish hue, and has a light dorsal line on the median of



THE CLOVER-LEAF WEEVIL

1, Framework of cocoon. 2, Cocoon some hours later. 3, Finished cocoon. 4, Pupa. 5, Larva feeding. 6, Side view of larva. (All enlarged)

the abdomen and most of the thorax. It usually assumes a curved position when at rest. It is from one-third of an inch to over half an inch in length. (Plate II, 5 and 6.)

The young larvae appearing from the eggs over so long a period in the fall attain various sizes before cold weather sets in, and then remain stationary until spring. It thus happens that larvae of nearly all stages of growth may be found in the field during late fall, winter, and early spring. During the cooler season they may be found at the bases of the plants curled up among the débris.

The larva passes through four molts, but the length of the different instars varies greatly, depending on temperature, food, and humidity. The following table, selected from extensive records, gives the length of the various instars, data for which were all obtained during the months of May, June, and July from eggs hatching in the spring:

Stage	Length of stage (days)
First instar	9, 9, 9, 9, 11, 14, 12, 11, 9, 10, 10
Second instar	9, 14, 14, 14, 14, 11, 13, 11, 7, 8, 15
Third instar	14, 11, 13, 13, 9, 12, 10, 9, 8, 8, 9
Fourth instar	14, 13, 11, 12, 12, 14, 17, 12, 11, 10, 12
Prepupal period	3, 3, 2, 2, 3, 4, 5, 5, 3, 3, 4
In cocoon	8, 9, 9, 9, 8, 11, 10, 6, 7, 7, 8

It is seen that the period of the first instar varied from 9 to 14 days, with an average of a trifle over 10 days. The second instar varied from 9 to 15 days, with an average of about 12 days. The third instar varied from 9 to 14 days, with an average of about 10½ days. The pupal period averaged about 8 1-3 days. The larva spends from 2 to 5 days in spinning the cocoon and resting before it transforms to a pupa, a period designated in the table as the prepupal period.

During the fall the length of the instars is modified by the cool weather and considerably prolonged. The following records give data on some individuals carried through under insectary conditions during the months of October, November, December, and January[1]:

Stage	Length of stage (days)
First instar	9, 13, 12, 11, 12, 13, 12, 10
Second instar	16, 11, 20, 19, 27, 19, 13, 20
Third instar	33, 20, 24, 27, 22, 21, 19, 31
Fourth instar	28, 31, 25, 31, 28, 28, 31, 24
Prepupal period	7, 8, 9, 6, 7, 6, 8, 7
In cocoon	16, 16, 16, 18, 21, 15, 16, 17

[1] The writers are indebted to Dr. I. M. Hawley for much of these data.

The cocoon and the pupa

The cocoon is oval in form, about one-third of an inch through the long diameter, and one-fifth of an inch in width. It is light yellow in color at first, but becomes brown with age. It is formed just beneath the soil or among the débris at the bases of the plants, or occasionally higher among the stems of the clover. The larva first spins a framework of supporting threads (Plate II, 1), and then spins the open meshwork of the finished cocoon (Plate II, 2 and 3), which, as has been said, occupies from two to five days

The pupa is about one-fifth of an inch in length. It is yellowish green at first but becomes darker with age. It has recently been described in detail by Tower and Fenton (1920). The pupae are formed during the months of May and June.

The beetle

The beetle (Plate I, 4 and 5) is a snout weevil from one-fifth to two-fifths of an inch in length, brownish in color with the sides and the venter considerably paler. A detailed description is given by Titus (1911). The beetle usually remains in the cocoon from one to three days before emerging. The emergence takes place mainly during June and July.

NUMBER OF GENERATIONS

In the latitude of central New York, there is in most seasons but one generation of the weevil in a year. Farther south it will probably be found that there is more than one generation. Tower and Fenton (1920) remark that "observations made by different members of the Bureau of Entomology would indicate that ovipositing beetles in the latitude south of southern Indiana are capable of laying fertile eggs in the spring and that two broods sometimes, if not ordinarily, occur annually."

Our own observations made here at Ithaca indicate that in exceptional years beetles may survive the winter or emerge during mild spells in an open winter and early spring, and lay fertile eggs for a second generation. For example, the winter of 1918-19 was above the normal in temperature and below the normal in precipitation. In other words, it was a mild, open winter, and many weevils came through in an active condition capable of laying fertile eggs in the spring. Whether these weevils actually emerged in the fall before and lived through the winter, or whether they passed through their transformation during the mild open spells and early spring, the writers are unable to say. Many adults were found in late March and early April, some of which deposited fertile eggs which hatched normally in from thirteen to seventeen days. Some of the larvae were carried through to maturity in a cycle of from forty-four to forty-six days. These facts tend to confirm the conclusions of other observers, that the clover-leaf weevil may survive favorable

winters and become active enough in the spring to deposit eggs, thus producing exceptionally in this latitude a second generation. Moreover, these observations indicate strongly that farther south, where the winter conditions are habitually more favorable, there may be normally a second generation each year.

It is seen from a study of the records that the egg-laying period generally extends from the latter part of August through September and October into November, with the greatest activity in egg-laying during September. In New York State the hatching of the eggs takes place normally during September and October in the fall and during April in the spring. The larvae are found from September throughout the winter and the spring into May. The beetles begin to appear in very early June, perhaps in some seasons during the latter part of May; but as a rule they do not begin laying their eggs until August. Thus, in the case of the clover-leaf weevil there may be both a short and a very long incubation period for the eggs, and both a short and a long larval period, the period in each case depending mainly on the temperature. For example, eggs laid early in the fall will hatch in a short time, while those deposited late will not hatch until the following spring. Larvae appearing in the autumn will not mature until the following spring, while those emerging from eggs in April will mature in a comparatively short period.

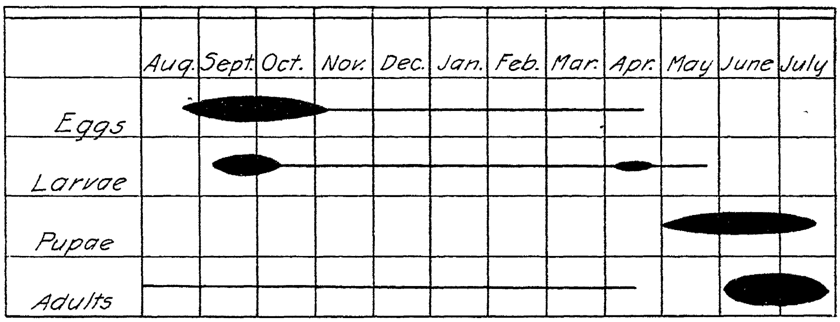


Fig. 1. STATUS OF CLOVER-LEAF WEEVIL UNDER NORMAL CONDITIONS OF ONE GENERATION IN NEW YORK

These essential facts are shown in a graphic way in figure 1. It will be noted that eggs exist from August to April, and that some of them do not hatch until April. There are two periods in which larvae are produced, once in the fall and again in April when the overwintering eggs hatch. Adults also may be found in nearly every month in the year.

Again, under certain conditions of winter temperature and humidity there may be a second generation within the year. Thus the life cycle of the clover-leaf weevil may be greatly modified by seasonal conditions.

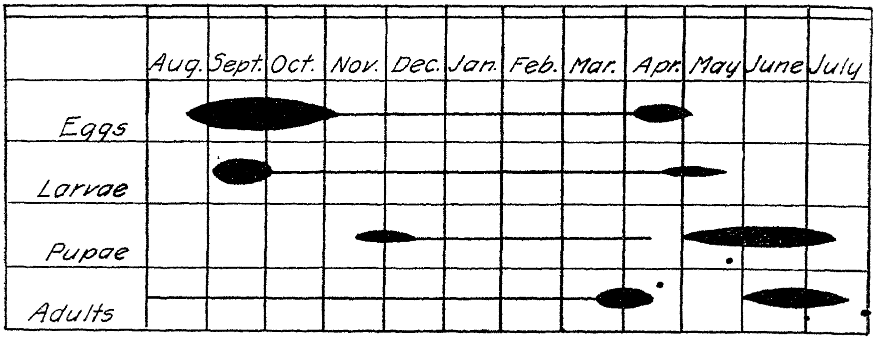


FIG. 2. STATUS OF CLOVER-LEAF WEEVIL WHEN THERE ARE TWO GENERATIONS IN NEW YORK

In figure 2 is shown what probably happens in New York State when there is a second generation of the weevil. There will be two periods in which new eggs, larvae, pupae, and adults will appear. The writers are not sure when those periods occur for the pupae, but they are probably about as indicated in the diagram.

MEANS OF CONTROL

Natural agencies

There are several natural factors that aid greatly in holding the clover-leaf weevil in check. Interestingly enough, no parasites have ever been bred from any stages of the insect in this country, so far as known. In Europe, however, several parasites of the larvae are known, but apparently none of them have yet reached this country.

The United States Bureau of Biological Survey (Beal, McAtee, and Kalmbach, 1916) reports that the weevil is preyed upon by at least twenty-five species of birds, among which the crow, the red-headed woodpecker, the nighthawk, the crow blackbird, and the purple martin have the highest records for destroying the adult weevils, while the savannah and vesper sparrows devour the most larvae. It has been shown also that poultry, especially chickens and turkeys, will eat many of the adult weevils and larvae if the fields are accessible to the fowls. During early spring a flock of fowls in a clover field would probably do much good in cleaning up the overwintering larvae.

By far the most effective natural control agent of the weevil is a fungus, *Empusa sphaerosperma*, which attacks the larvae usually under circumstances favorable for bringing about a high mortality. In all cases observed by the writers, the weather conditions at the time of the most effective work of the fungus have been fairly cool and abnormally humid. For example, in May of 1919 the fungus was very active and

destructive to the larvae of the clover-leaf weevil, especially in Wyoming County, New York. The records of the weather station in the near vicinity show that the average temperature during the days in which the fungus was most active averaged 62.3°+. Moreover, the rainfall was above the normal and totaled 8.39 inches for the month. Most of this precipitation took place from the 4th to the 24th of May, the period during which the fungus developed most rapidly and did most of its work in destroying the larvae. At Ithaca, where the fungus was active also, the average temperature from the 9th to the 22d of May inclusive was 45.2°+ and the rainfall for the month totaled 5.25 inches, which was 1.82 inches above the normal. Thus it would appear that generally cool temperatures, with an abundance of moisture, constitute favorable conditions for the development of the fungus.

The fungus readily spreads from grub to grub by the spores, which are shot off and fall upon the larvae. Thus the disease, once started in a field, runs rapidly throughout the whole area infested with larvae.

In the field near Warsaw, New York, consisting of eight acres of first-year clover sown the year before to wheat, the larvae occurred in enormous numbers and for a time devoured the clover about as fast as it grew. On May 17 the senior author visited the field and found the larvae in all stages of growth, many being nearly full-grown. From six to eight grubs were present at the base of each plant. But the conspicuous thing about them at this time was the large numbers of individuals that were dead or dying from the attacks of *Empusa sphaerosperma*. The sick larvae had climbed blades of grass, stems of clover, and stubble of wheat, around which they had curled in a characteristic position (fig. 3). Each larva would turn from a normal green to a velvety grayish white and in twenty-four hours become a blackened, shriveled mass. The progress of the disease in its destruction of the larvae was observed by W. S. Wilts, Assistant Farm Bureau Agent. He stated that the grubs were so effectively checked by the fungus that they caused no material damage after the middle of May, and that the clover recuperated from the early injury and made a fine growth. Similar conditions were observed at Ithaca.

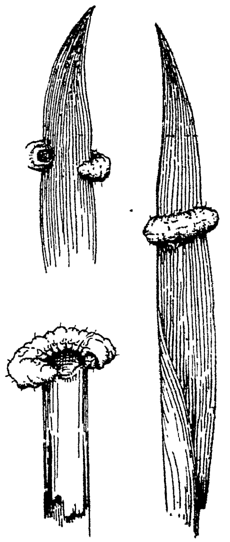


FIG. 3. DEAD AND DYING LARVAE CURLED ABOUT BLADES OF GRASS AND STUBBLE

Other observers have recorded the effectiveness of this fungus in holding the larvae in check in seasons of abnormal abundance. For instance, Folsom (1909) says: "The reported outbreaks of the larvae in spring have almost always been suppressed by the virulent disease just described [*Empusa sphaerosperma*]. This disease prevents the summer damage by the beetles, often killing the larvae before they have done much injury."

Artificial control

If the infestation is deemed serious enough and the prospects of injury are great enough, the field of clover could be sprayed with poison in early May, when the larvae are likely to be particularly active. It is doubtful, however, whether red clover will ever be considered by the average grower of sufficient value as a hay crop to justify the expense of spraying. The most satisfactory poison would be arsenate of lead, in either the paste or the powdered form. If the paste is preferred, it should be used at the rate of 8 pounds to 100 gallons of water. If the powdered form is used, 4 pounds to 100 gallons will be sufficient. In either case 5 pounds of soap should be added, to make the solution stick to the leaves of the clover.

Arsenate of calcium, which is cheaper and higher in arsenic content, can probably be used for spraying clover and may prove more effective than arsenate of lead. There would probably not be much danger of serious burning of the plants. The powdered form may be used at the rate of 3 pounds to 100 gallons of water.

Probably a well-equipped potato sprayer would be most satisfactory for applying the poison.

In general, the most practical method of dealing with outbreaks of this insect is to either cut the clover back in May or use it for pasture in spring. Usually, serious injury does not occur until the clover is in its second year's growth, and cutting it or using it for pasture does not injure the seed crop and does aid in controlling the more serious insect pests that attack the plants later and prevent the production of seed. After the second year of red clover it should be plowed under in order to check the leaf weevil and also to destroy the clover root borer.

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An Economic Study of the Production of Canning Crops in New York

L. J. Norton

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CONTENTS

AN ECONOMIC STUDY OF THE PRODUCTION OF CANNING CROPS IN NEW YORK[1]

L. J. NORTON

The investigation described herein was conducted for two general purposes. The first was to obtain basic information regarding the production and cost of production of the principal crops grown in New York for canning factories. The second was to study some of the factors influencing the economical production of these crops.

METHODS OF INVESTIGATION

The data on cost of production were collected by the survey and the accounting method. In the survey method a number of the farmers growing the crop under consideration in some of the important centers of production were visited by representatives of the New York State College of Agriculture. Detailed information was obtained from each farmer concerning the methods practiced in growing the crop and the costs of production. A copy of one of the blanks used is shown on pages 79 to 82.

In the accounting method, farmers were furnished with blank account books with simple directions as to the records to be kept. In these books the farmers kept a record of all the items of expense incurred on the crop, of all receipts from the crop, and of the hours of human, horse, and tractor labor on the crop. At the end of the season the farmers were visited by a representative of the College of Agriculture, who checked the accounts and obtained the additional information necessary to calculate costs. This method does not entirely eliminate estimating. Such items as land values, rates of application of manure, and the cost of labor per hour, must be estimated. Since the results obtained by the survey method check closely with those obtained by the accounting method (tables 38 and 73, pages 40 and 66, respectively), all cost figures include data obtained by both methods unless otherwise stated.

COST OF PRODUCTION

The term *cost of production*, as used in this study, refers to the total expenses incurred directly or indirectly in the production of a crop. In addition to the actual cash outlays, it includes a return to the farmer for his labor, based on the outlay that would be necessary to hire a similar grade of labor, and a six-per-cent return on the investment in land, horses, and machinery used in producing the crop. Risk also should be included as an item of cost. In making comparisons between crops, consideration

[1] Also presented to the Faculty of the Graduate School of Cornell University, September, 1921, as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy.

AUTHOR'S ACKNOWLEDGMENT. The investigation was conducted under the direction of Professor G. F. Warren. It was made possible thru the cooperation of the New York State College of Agriculture with the New York Canning Crops Cooperative Association. New York growers of canning crops furnished the data on which the study was based. H. S. Mills, of the Department of Vegetable Gardening, assisted in obtaining and summarizing the data. To these and to many others who furnished valuable assistance, the writer is indebted.

should be given to the relative risks involved. In this study, risk has not been included as a separate item of cost on individual farms, but some allowance for risk has been made by including, in the averages, costs for all farms visited. Some of these farms had partial or complete crop failures.

The question of what items should be included in calculating the cost of any product raises certain difficulties. In agriculture the problem is complicated because on most farms a number of products are grown which are interrelated in a general system of farming, and because many enterprises yield two products—wheat and straw, corn and fodder, mutton and wool.

The problem is to obtain information by which one enterprise may be compared with another on the same farm, and the same enterprise may be compared on different farms. It is necessary, therefore, that uniform methods be employed. The methods used in this study have followed as closely as possible the principles laid down in the report of the committee appointed by the Secretary of Agriculture of the United States to make recommendations concerning methods of procedure in cost-of-production studies.[2]

ITEMS INCLUDED IN COST

Seed, plants, and fertilizer were charged at cost. All fertilizer applied in 1920 was charged to the crop of that year.

Manure was valued at the farmer's estimate, or, if no estimate was made, at $2 a ton at the barn. To allow for residual value, manure applied to the land that was in canning crops in 1920 was charged to the 1920 crop as follows: of the manure applied in 1920, 40 per cent; of the manure applied in 1919, 30 per cent; of the manure applied in 1918, 20 per cent; of the manure applied in 1917, 10 per cent.

Lime was charged at cost. The charge to the 1920 crop was based on the length of the rotation, the cost being distributed over the number of years in the rotation. In most cases 20 per cent of the cost of the applications made during the preceding five years to the land on which the 1920 crop was grown, was charged to the 1920 crop.

Labor hauling and spreading manure and lime. The time required to perform these operations was obtained separately. The crop was charged with the same percentage of the cost of labor as of the manure and lime involved. For example, if 40 per cent of the manure was charged to the crop, 40 per cent of the time spent in hauling and spreading it was charged also.

Hired labor was charged at cost. Where men were hired by the month, the total cost per month, including the value of board or privileges furnished, was divided by the estimated number of hours worked per month, in most cases 260.

Operator's and other family labor was charged at what the farmer estimated it would cost to hire labor of the same grade.

Horse labor was charged at 24.5 cents per hour on all farms except when teams were hired for special work, such as hauling peas. In such cases horse labor was charged at the price paid. The rate given was the preliminary average of the cost per hour of horse labor in 1919 on thirty-

[2] U. S. Agr. Dept., Circular 132 (Office of the Secretary), pages 9-15. 1919.

eight New York farms which cooperated with the New York State College of Agriculture in keeping complete cost accounts of their farm operations. This rate covers all the costs of keeping horses on these farms, among which are charges for interest on the average investment, for depreciation, for the use of buildings, for time spent in taking care of horses, and for the value of home-grown feeds fed to horses. The use of this uniform figure as the cost of horse labor on a particular farm is only approximately accurate, as this cost varies between farms; but it is more nearly accurate when used as the average cost on a group of farms.

Use of equipment was charged on all farms at 8.2 cents per hour of horse labor. This figure was the average cost on the cost-account farms for 1919. The reason for distributing equipment costs, which include machinery and harnesses, on the basis of the hours of horse labor, is that most farm machinery is drawn by horses and the cost varies approximately with the number of horses driven.

In 1920 the cost per hour of horse labor on thirty-three New York farms which kept cost accounts was 21.9 cents. The cost of equipment used on these farms was 9.5 cents per hour of horse labor. It will be noted that the horse-labor rate was lower than the rate used in this study, while the equipment rate was higher. The combined rate per hour for these two items was approximately one cent lower than the rate at which it was charged. The lower horse-labor rate was due to the reduction in the cost of feed during the latter part of the year. The higher equipment cost was due to the general increase in replacement and repair costs which continued in 1920.

Use of tractor, if hired, was charged at cost; if not hired, at $1.75 per hour. This figure was estimated, using as a basis the data obtained in a study of the costs of tractor operation for the year 1919.[3]

Use of automobile was charged at 10 cents per mile.

Use of trucks was charged at cost when hired, or, if not hired, at the rate that would be paid for similar trucks.

Interest was charged at 6 per cent per annum on all costs except the charge for use of land and that for seed and plants which were not paid for until the end of the season. Interest was computed from the average date when the costs were incurred, to the date of payment by the canning company.

Use of land. Where cash rent was paid for land, the rent paid per acre, plus taxes and other costs which the operator incurred, was used as the charge for use of land. The charge for use of land owned or worked on shares was calculated by multiplying the farmer's estimate of the value of the bare crop land by 8.2 per cent. The farm expenses chargeable to crop land in 1919 amounted to 8.2 per cent of the value of the crop land on the New York farms keeping cost accounts in that year. This rate included 6 per cent interest on the value of the land, taxes, and all other costs of upkeep. The crop-land costs in 1920 on thirty-three farms on which cost accounts were kept were 8.4 per cent of the value. This figure was not available when the costs were calculated. If the land was double-cropped, the canning crop was charged one-half the annual cost of use of land.

[3] Cornell University Agr. Exp. Sta., Bulletin 405. 1921.

Some of the methods used have been criticized at various times and by various persons as not being a correct basis of cost. The principal criticisms have been concerning the inclusion of a return for operator's labor and for interest on investment, particularly land; and the practices of charging home-grown supplies from one enterprise to another, and crediting by-products, at market value and not cost.

In considering these criticisms, the purpose for which the cost figures are to be used must be kept in mind. The primary uses of cost figures as here calculated are to compare different enterprises on the same farm, or the same enterprise on different farms or groups of farms, and as a basis for studying the relative efficiency of different methods of production. In order to be useful for these purposes, cost figures must include common elements. If on one farm the operator does all the work and on another all the labor is hired, unless the operator's time is included on the one, the two cannot be compared accurately. Similarly, in the case of land, if one farmer uses land valued at $50, and another land valued at $100, profitable comparisons cannot be made without including interest on the varying values. Land is often held to be different from other productive factors because its value is determined by the prices of its products and does not determine their prices. This is true, and the same is true of any other factor in production, varying only in the degree to which it can be put to other uses. The value of a factory having one use will depend, after it has been constructed, on the price at which its product can be sold. But if a factory that has more than one use is being studied to determine to what use it will be put, and if one product involves equipment costing $5000 while another involves equipment costing $10,000, unless returns on this capital are included in the comparison of costs such a comparison is of little value in determining which product should be manufactured.

The practices of charging home-grown supplies transferred from one enterprise to another, and crediting by-products at market value instead of at cost, are followed by most manufacturing enterprises having comparable problems when they desire to calculate the cost of a particular product. In order to compare the different enterprises on a farm, the returns must be comparable. If one farm raises oats for horse feed and another farm buys them, the costs of horse labor will not be comparable unless oats are in both cases charged at market value.

THE CANNING INDUSTRY

The canning industry in New York is based on a large volume of a variety of high-quality products. The climate and soil conditions prevailing in the canning sections of the State are such that a variety of fruits and vegetables can be economically produced.

Canning factories usually are located close to the land which produces the principal crops that are canned. Most of the factories in New York State pack a variety of products. In some cases the area in which the factory is located is not particularly well adapted to raising all the products that are canned, but the larger companies, operating a number of plants, have distributed them so that they have one or more plants located in a section well adapted to each crop.

Both fruits and vegetables are canned in the State, but in this investigation only the vegetable branch of the industry was considered. The leading vegetables canned are peas, corn, tomatoes, and string beans. Beets, cabbage in the form of sauerkraut, and spinach, are among the other vegetables canned.

Climatic and soil conditions determine the regions in which the raw products can be grown most advantageously. There are other factors also, however, which give relative advantages to various sections of the country. The most important of these is the location with reference to markets. New York State is located in the most densely populated part of the United States. In 1920 the combined population of the New England States and New York, New Jersey, Delaware, Maryland, and Pennsylvania, was nearly 30 per cent of the total population of the United States. The proportion of the total production of three of the leading kinds of canned goods in these States is given in table 1:

TABLE 1. POPULATION AND PROPORTIONAL PRODUCTION OF CANNED GOODS IN NEW ENGLAND, NEW YORK, NEW JERSEY, DELAWARE, MARYLAND, AND PENNSYLVANIA

	Per cent of United States total	
	1906 to 1910	1911 to 1920
Population	29.6*	29.8†
Peas‡	38.0	29.0
Corn‡	36.8	34.4
Tomatoes‡	60.6	56.2

*Population according to census of 1910.
†Population according to census of 1920.
‡The data in regard to the packs were obtained from the *Almanac of the Canning Industry*, published by the *Canning Trade*, Baltimore, Maryland.

The proportion of these three kinds of canned goods packed in these States was less in the period from 1911 to 1920 than in the earlier period, from 1906 to 1910. Measuring total consumption by total population, these States packed just about enough peas and corn to supply their needs and produced a surplus of canned tomatoes. Canners of corn and peas in the States listed have an advantage in having a near-by market for their product, while the tomato canners must ship a part of their pack to more distant markets.

The freight rates prevailing during the winter of 1920–21 from various producing centers to various large cities, and the estimated equivalent per ton of fresh tomatoes and green peas, are given in table 2.

If a canner of peas in Wisconsin and one in New York, respectively, located so as to have the freight rates shown in table 2, were shipping to New York City, the New York canner would have an advantage over the Wisconsin canner in freight rates on the canned goods amounting to about $15 per ton of shelled peas. When shipping to Pittsburg the New York canner would have an advantage amounting to about $6 per ton of shelled peas.

TABLE 2. FREIGHT RATES ON CANNED GOODS, AND EQUIVALENTS PER TON OF VEGETABLES

	Rates (car-lot) per 100 pounds of canned goods	Equivalent per ton	
		Fresh tomatoes*	Green peas†
To New York from:			
Oconomowoc, Wisconsin	$0.70	......	$28.00
Frankfort, Indiana	0.60	$ 7.20	......
Rochester, New York	0.315	3.78	12.60
Woodstown, New Jersey	0.24	2.88	......
Oakland, California‡	1.205	14.46	......
To Chicago from:			
Oconomowoc, Wisconsin	$0.23	......	$ 9.20
Frankfort, Indiana	0.24	$ 2.88	......
Rochester, New York	0.44	5.28	17.60
Woodstown, New Jersey	0.64	7.68	......
Oakland, California	1.205	14.46	......
To Pittsburg from.			
Oconomowoc, Wisconsin	$0.44	......	$17.60
Frankfort, Indiana	0.355	$ 4.26	......
Rochester, New York	0.30	3.60	12.00
Woodstown, New Jersey	0.38	4.56	......
Oakland, California	1.205	14.46	......

* 2000 pounds of fresh tomatoes is considered equivalent to 1200 pounds of canned goods.
† 2000 pounds of green peas is considered equivalent to 4000 pounds of canned goods.
‡ The rates from California to New York City were actually less than those given above, because the rate by water from California to New York City was much lower than the rail rate. The ocean rate from the Pacific Coast to New York City was less than the rail rate from middle-western points to New York City.

Canning factories located in the more densely populated regions ordinarily would be expected to have to pay more to get their raw produce because of the higher prices for all kinds of agricultural products in those sections. So long as the consumption of the region exceeds the production, such factories are able to pay a higher price for the raw product because of the saving on freight. If production exceeds consumption, they will not be able to pay as high a price. However, if a surplus is produced continuously, it is very likely that the region has some special advantage in the growing of the crop which makes production possible at such a price as to enable the local canners to compete with canners with whom they are at a disadvantage as regards freight rates.

PRACTICES IN BUYING CANNING CROPS

Most of the crops grown for canning factories in New York State are raised under contract. Under the form of contract in common use in the State, the canner agrees to take the total product of a certain number of acres of a crop at a price fixed in the contract. These contracts are usually made in the late winter or early spring. The price to be paid, the price at which seed or plants are to be charged, the dates of payment,

certain conditions as to quality, and other terms of sale, are specified in the contract.

The canners in turn usually sell the canned goods, for delivery when they are packed, to wholesale grocers or other distributors. These are known as "futures." The quantity of "futures" of a given product which a canner sells is usually a certain proportion of a normal yield on the acreage for which he has contracted.

In other sections of the country, particularly in Maryland and Delaware, a considerable acreage of tomatoes not under contract is grown. In every community in these sections there are several buyers of tomatoes, and in the fall a competitive price is established. In the vicinity of Rochester and Buffalo in New York, there are market-gardening sections in which tomatoes are grown for the city markets. Some of these tomatoes may be sold to canners when the market conditions are not good. Such tomatoes, being surplus product from market gardens, can be sold at a lower price than tomatoes grown under contract, all of which have to be sold to a factory at a fixed price.

The part of their supply of vegetables which the companies grow on their own farms is, of course, not contracted for. Beans are the principal crop so grown. Farmers ordinarily do not have enough hired labor to grow and harvest this crop satisfactorily. The canning companies that raise beans employ a gang of laborers for hoeing and picking. When beans are grown under contract, the companies usually furnish the pickers.

Beets are usually not contracted for but are bought when they are ready to harvest. The price depends on the proportion of the various-sized beets. The greater the proportion of small-sized beets, the more they are worth for canning. Cabbage may be contracted for or bought at the market price in the fall. Spinach, unless grown on the canner's own farm, is usually bought from truck growers at the prevailing market price.

The local monopoly which the factory usually has makes it practically necessary that the price be set before the crop is planted, or at least that the method of arriving at a price be defined. There are advantages and disadvantages to the farmer in this method of sale. He is sure of the price, but he is in no way certain of the total returns he will receive. The profitable years, in the case of contract crops, are years when yields are good. When the yields of crops produced for the open market, such as cabbage and potatoes, are high, low prices usually prevail, but in years of low yields there is usually a compensating increase in the price. There is no such increase in the price of contract crops when the yields are low, and therefore such years are very unprofitable.

In order to secure a constant supply of any product, the price must be high enough to give to a sufficient number of producers returns comparable with what they may expect from other crops that work in equally well with their system of farming. Probably the return could be slightly less in the case of a crop the price of which is guaranteed than in the case of crops grown without a price guaranteed, because the uncertainties of price are eliminated. If data were available on the average costs and

returns from competing crops, the price necessary to maintain production of any crop could be ascertained with a fair degree of accuracy. The return per hour of human labor on the crop under consideration is probably the best measure of whether a price is adequate to maintain production. This should be equal to the returns from competing crops that fit in equally well with the system of farming. The return per hour should be based on the average yield and price over a series of years on the farms under consideration. In any particular year the crop may return either more or less per hour than the average.

PEAS FOR THE CANNING FACTORY

Peas for canning are grown chiefly in the States bordering the Great Lakes, where the climate is cool. Wisconsin and New York are the two leading States. The area in which peas are canned in New York extends from Oneida County, in the central part of the State, across the northwestern part to Lake Erie and the Niagara River. Peas are grown

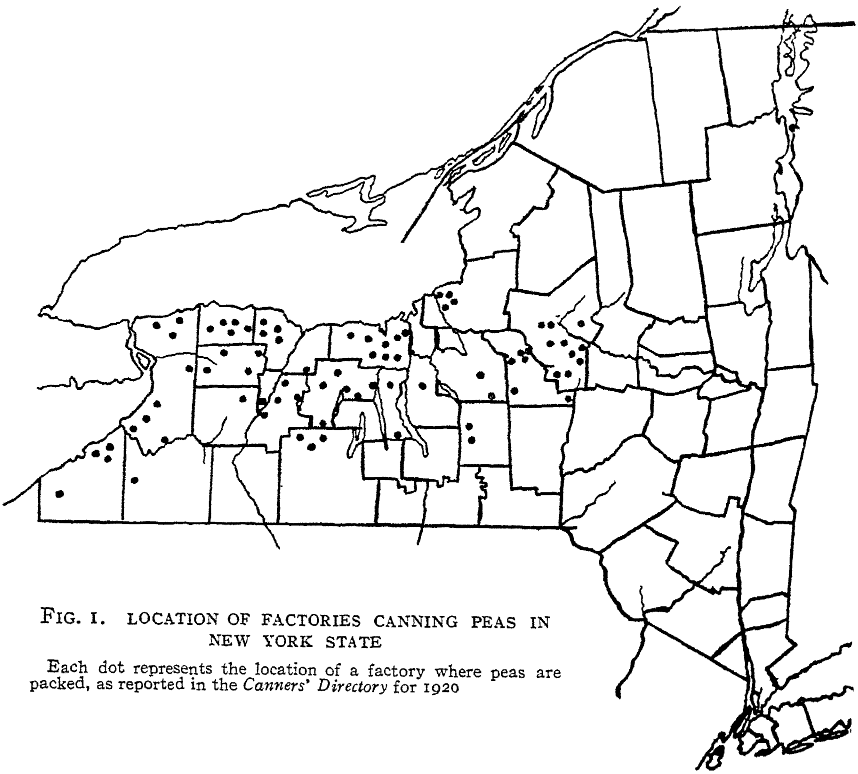

FIG. I. LOCATION OF FACTORIES CANNING PEAS IN NEW YORK STATE

Each dot represents the location of a factory where peas are packed, as reported in the *Canners' Directory* for 1920

in many localities distributed thruout this section of the State, as is shown in figure 1. In most of the localities where peas are grown there is a considerable area of fairly deep, well-drained soil, usually well supplied with lime.

Cost data on the crop were obtained by both the account and survey methods. The location of the four areas in which surveys were made is shown in figure 2. The number of farms on which cost figures on peas were obtained by each method is shown in table 3.

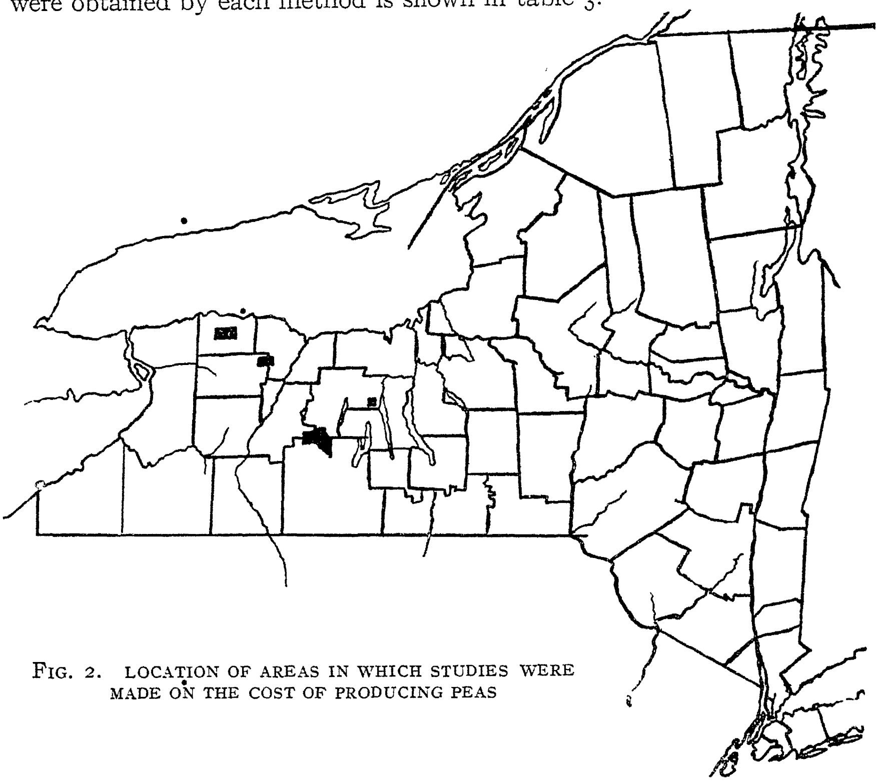

FIG. 2. LOCATION OF AREAS IN WHICH STUDIES WERE MADE ON THE COST OF PRODUCING PEAS

TABLE 3. FARMS ON WHICH COST FIGURES ON PEAS WERE OBTAINED IN 1920

Area	Accounts	Records	Total
Orleans	12	64	76
Genesee	5	43	48
Steuben	14	39	53
Ontario	1	49	50
Other counties	24	11	35
Total	56	206	262

AGRICULTURAL CONDITIONS IN THE AREAS STUDIED

Orleans area

The principal factory in Orleans County was located at Albion and was operated by the New York Canners, Inc. Peas were raised for this factory over the greater part of central Orleans County. The peas were

threshed at the factory, and at three outlying viner stations from which the shelled peas were hauled by motor trucks to the factory. These viner stations increased the territory from which the factory could procure peas, because the distance which peas can be hauled economically before being threshed is limited. The viner stations were located, in relation to the factory, 5 miles east, 7 miles north, and 8 miles west, respectively. There were several other smaller factories that packed peas in Orleans County.

There is no soil survey of Orleans County, but the soils on which peas are grown would probably be classed chiefly as Ontario loam, silt loam, and fine sandy loam, Lockport stony clay loam, and Dunkirk gravelly sandy loam. The land is, in general, level. This county is located in the Lake Ontario fruit belt, and in the section in which peas are grown, apples are the most important crop. Hay, winter wheat, oats, tomatoes, pears, and peaches are also important, and a great variety of other crops are grown (table 4).

TABLE 4. CROPS GROWN IN 1920 ON FARMS FOR WHICH COST DATA ON PEAS WERE OBTAINED

Crop	Acres per farm				Per cent of total crop acres			
	Orleans	Genesee	Steuben	Ontario	Orleans	Genesee	Steuben	Ontario
Peas	5.0	8.5	5.8	3.6	6.7	9.8	7.4	4.8
Beans	0.6	1.9	0.8	1.3	0.8	2.2	1.0	1.8
Cabbage	1.4	0.5	......	4.2	1.9	0.6	......	5.7
Corn for grain	3.4	4.4	2.2	6.6	4.6	5.1	2.8	8.8
Corn for silage	2.5	2.9	0.7	1.7	3.4	3.3	0.9	2.3
Sweet corn	1.4	1.0	0.9	0.9	1.9	1.2	1.1	1.3
Corn for fodder	......	......	0.1	......	......	......	0.1	......
Potatoes	1.9	2.6	9.1	1.7	2.5	3.0	11.9	2.3
Tomatoes	2.6	0.2	......	......	3.5	0.3	......	......
Oats	5.7	7.5	11.0	6.0	7.7	8.7	14.2	8.1
Barley	1.5	3.9	1.2	5.0	2.0	4.6	1.5	6.6
Oats and barley	0.4	......	0.1	0.4	0.6	......	0.2	0.5
Buckwheat	0.3	0.3	1.7	1.8	0.5	0.4	2.2	2.5
Winter wheat	14.3	25.1	5.7	14.6	19.3	28.9	7.4	19.4
Spring wheat	......	......	0.1	0.2	......	......	0.1	0.3
Rye	......	......	2.0	0.2	......	......	2.6	0.3
Hay	19.6	19.0	34.4	16.3	26.4	21.9	44.1	22.1
Alfalfa	0.7	5.8	0.6	1.5	0.9	6.7	0.8	2.0
Orchard, bearing	11.5	2.9	1.1	7.3	15.5	3.3	1.4	9.7
Orchard, not bearing	1.4	......	......	0.4	1.8	......	......	0.5
Other crops	......	......	0.2	0.9	......	......	0.3	1.0
Total crops	74.2	86.5	77.7	74.6	100.0	100.0	100.0	100.0
Total acres in farm	104.0	123.6	142.8	101.3	......	......	......	......

Genesee area

The farms included in the Genesee area are located in Genesee and Monroe Counties. The factory for which they raised peas was located at Bergen and was operated by the Curtice Brothers Company. All the peas were threshed at the factory because there was a sufficiently large acreage of land adapted to peas close enough to the factory to supply its requirements. The acreages grown per farm in this section were rather large, and all the farms that raised any considerable acreage had several varieties. Since the different varieties ripened at different dates, the time in which the peas could be harvested in condition suitable for canning was extended and it was possible for the farms to grow larger acreages.

The topography in this section is level to rolling. The soils on which peas were grown are for the most part Ontario loam and fine sandy loam. This is a general-farming section, in which wheat is the most important crop. Next to wheat and hay, more acres of peas were grown on these farms than any other crop (table 4).

Steuben area

The farms in the Steuben area are located in three counties — Steuben, Ontario, and Livingston. The parts of the three counties included in the area have more or less similar conditions. The Steuben Products Company operated four factories in this area, located respectively at Cohocton, Atlanta, and Wayland, in Steuben County, and Naples in Ontario County. A few outlying viner stations were operated.

The topography in this area is extremely varied. The farms may be divided into two classes, the hill and the valley. The valleys are nearly level, with steep banks on both sides. The tops of the hills are rolling. The soils in general are light, fairly deep, and not very well supplied with lime.

This is a very important potato-producing section. Twelve per cent of the land in crops on the farms visited was in potatoes in 1920. Other cultivated crops are not important. Peas were the second cash crop in importance (table 4). A considerable proportion of the land in this area is in pasture, woods, and waste. The farms are larger than in the other areas, but the acreage of crops grown per farm is about the same.

Ontario area

All the farms in the Ontario area are located in the eastern part of the county. The company for which the peas were raised, the Geneva Preserving Company, had a factory in the city of Geneva. Two viner stations were operated in the territory covered. The topography is level to rolling, and the soils are chiefly Ontario loam and fine sandy loam. Apples, cabbage, and wheat are important cash crops (table 4).

Peas were of less importance in this section than in any of the other areas. One of the viner stations was in a new location. Peas were a new crop to most of the farmers and no large acreages were grown. In the future, if the experience of other sections is repeated, some of the growers will probably drop out; others will put in larger acreages, and the acreage of peas per farm on the farms growing peas will be more comparable to that in the other areas.

Other counties

The farms which are designated as in "other counties" are located as follows: Niagara County, 2; Wayne County, 10; Ontario County, 6; Seneca County, 4; Cayuga County, 6; Onondaga County, 4; Madison County, 2; Cortland County, 1. On about 60 per cent of these farms, accounts were kept by farmers. These farms probably had higher yields per acre and lower costs per ton than the average of the farms in the sections in which they are located.

COST OF PRODUCTION

The average cost of producing an acre of peas in 1920 on the 262 farms in all areas in which data were obtained, is given in table 5, and the average cost in each area is given in table 6.

TABLE 5. AVERAGE COST OF PRODUCING AN ACRE OF PEAS ON 262 NEW YORK FARMS GROWING 1468 ACRES IN 1920

(Average yield per acre, 2246 pounds)

Item	Quantity per acre	Cost per acre	Per cent of total cost
Seed	4.0 bu.	$15.71	22.0
Fertilizer	164.0 lbs.	2.82	3.9
Manure charged to peas	2.8 tons	5.66	7.8
Lime charged to peas	52.0 lbs.	0.10	0.1
Labor growing peas:			
Human	15.8 hrs.	6.93	9.6
Horse	37.5 hrs.	9.18	12.7
Use of equipment	37.5 hrs.	3.07	4.3
Use of tractor	0.3 hr.	0.61	0.8
Use of automobile and truck	....	0.03	....
Miscellaneous growing expenses	....	0.05	0.1
Interest on growing costs	....	0.61	0.8
Use of land	....	8.95	12.4
Total growing cost	....	$53.72	74.5
Labor harvesting peas:			
Human	21.8 hrs.	$9.10	12.6
Horse	26.2 hrs.	6.43	8.9
Use of equipment	26.2 hrs.	2.16	3.0
Use of automobile, truck, and tractor	....	0.17	0.2
Miscellaneous harvesting expenses	....	0.36	0.5
Interest on harvesting costs	....	0.20	0.3
Total harvesting cost	....	$18.42	25.5
Total cost of crop	....	$72.14	100.0
Value of ensilage	....	2.73	3.8
Net cost of shelled peas	....	$69.41	96.2
Shelled peas sold to factory	1.123 tons	$90.34	....
Price received per ton	....	$80.44	....
Cost per ton	....	$61.81	....

Estimating average costs

The yield per acre in 1920 on these farms was somewhat higher than the average yield would be over a period of years. The average yield of canning-factory peas for the State during the past four years has been about 1800 pounds per acre. The yields in tons as reported by the United States Bureau of Crop Estimates were: 1917, 0.7 ton; 1918, 1.1 tons; 1919, 0.8 ton; 1920, 1.0 ton. The gains on a crop in years when the yield per acre is good must be sufficient to offset the losses in years when the yield is poor. The average cost of growing a ton of peas, and the average quantities of the materials necessary to produce a ton of peas if the yield is 1800 pounds per acre, can be estimated. The costs per acre up to harvest are independent of the fluctuation in yield. The most important factors causing variation in yield are the weather and any change in the

TABLE 6. AVERAGE COST OF PRODUCING AN ACRE OF PEAS IN 1920 IN DIFFERENT AREAS

Item	On 76 farms in the Orleans area growing 376.7 acres		On 48 farms in the Genesee area growing 406.5 acres		On 53 farms in the Steuben area growing 300 acres		On 50 farms in the Ontario area growing 179.6 acres		On 35 farms in the other counties growing 205.2 acres	
	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre
Seed	4.0 bu.	$15.98	4.0 bu.	$16.12	4.2 bu.	$14.63	4.1 bu.	$16.39	3.9 bu.	$15.42
Fertilizer	245.0 lbs.	4.05	80.0 lbs.	1.40	123.0 lbs.	2.31	207.0 lbs.	3.56	203.0 lbs.	3.51
Manure charged to peas	2.4 tons	5.11	3.0 tons	6.22	3.3 tons	6.48	2.6 tons	4.98	2.5 tons	4.98
Lime charged to peas	35.0 lbs.	0.06	22.0 lbs.	0.03	155.0 lbs.	0.32	4.0 lbs.	0.01	31.0 lbs.	0.07
Labor growing peas:										
Human	17.2 hrs.	7.99	15.0 hrs.	7.19	16.3 hrs.	6.24	15.9 hrs.	6.61	14.2 hrs.	5.76
Horse	37.8 hrs.	9.25	41.7 hrs.	10.22	35.7 hrs.	8.74	34.3 hrs.	8.40	34.2 hrs.	8.39
Use of equipment	37.8 hrs.	3.10	41.7 hrs.	3.42	35.7 hrs.	2.93	34.3 hrs.	2.81	34.2 hrs.	2.81
Use of tractor	0.4 hr.	0.75	0.2 hr.	0.28	0.3 hr.	0.45	0.7 hr.	1.23	0.4 hr.	0.69
Use of automobile and truck	....	0.03	....	0.02	....	0.01	....	0.13	....	0.04
Miscellaneous growing expenses	....	0.07	....	.....	....	.....	....	.....	....	0.18
Interest on growing costs	....	0.75	....	0.49	....	0.57	....	0.62	....	0.63
Use of land	....	9.14	....	9.25	....	7.73	....	9.75	....	9.13
Total growing cost	....	$56.28	....	$54.64	....	$50.41	....	$54.49	....	$51.61
Labor harvesting peas:										
Human	21.4 hrs.	$9.39	16.4 hrs.	$7.15	29.7 hrs.	$11.47	24.2 hrs.	$9.76	19.9 hrs.	$8.46
Horse	25.3 hrs.	6.20	22.3 hrs.	5.45	35.2 hrs.	8.63	28.1 hrs.	6.88	21.2 hrs.	5.19
Use of equipment	25.3 hrs.	2.08	22.3 hrs.	1.83	35.2 hrs.	2.89	28.1 hrs.	2.30	21.2 hrs.	1.74
Use of automobile, truck, and tractor	....	0.20	....	0.09	....	0.28	....	0.09	....	0.19
Miscellaneous harvesting expenses	....	0.03	....	0.76	....	0.65	....	0.05	....	0.02
Interest on harvesting costs	....	0.21	....	0.15	....	0.23	....	0.27	....	0.19
Total harvesting cost	....	$18.11	....	$15.44	....	$24.15	....	$19.35	....	$15.79
Total cost of crop	....	$74.39	....	$70.08	....	$74.56	....	$73.84	....	$67.40
Value of ensilage	....	4.76	....	0.13	....	2.89	....	1.94	....	4.63
Net cost of shelled peas	....	$69.63	....	$69.95	....	$71.67	....	$71.90	....	$62.77
Shelled peas sold to factory	0.986 ton	$78.82	1.100 tons	$87.07	1.317 tons	$107.97	1.050 tons	$87.31	1.204 tons	$95.28
Price received per ton	....	$80.00	....	$79.15	....	$82.00	....	$83.15	....	$79.14
Cost per ton	....	$70.62	....	$63.59	....	$54.42	....	$68.48	....	$52.13

requirements of the factories regarding the time of harvest. The cost of harvesting will vary with the yield. Basing the calculation on these assumptions, the average cost per ton of shelled peas would have been $73.66 if the yield had been 1800 pounds per acre (table 7). This figure is very close to the cost in 1920 on a group of farms, the average yield of which was approximately 1800 pounds.

TABLE 7. ESTIMATED COST OF PRODUCING ONE TON OF PEAS IN 1920 WITH A YIELD OF 1800 POUNDS PER ACRE

(Based on data from 262 farms)

Cost of growing......................$53.72 ÷ 0.9 (0.9 ton = 1800 pounds)	= $59.69
Cost of harvesting............$18.42 ÷ 1.123 (tons, average yield in 1920)	= $16.40
Total cost per ton of peas..	$76.09
Value of ensilage.................................$2.73 ÷ 1.123 (tons)	= $2.43
Estimated net cost per ton of peas..	$73.66

In table 8 are given the quantities of the principal items required to produce one ton of shelled peas with a yield of 1800 pounds per acre. The items of cost included in this table made up approximately 97 per cent of the total cost. Costs change with changes in price. By using the figures for the average quantities of the various items required to produce a crop, the cost with different prices may be estimated. These quantities were calculated by the method illustrated in table 7. The quantities of all items in the growing cost were divided by 0.9. This gave the quantity of these items required to grow one ton with an average yield of 1800 pounds. Similarly, the quantities of all items in harvesting costs were divided by 1.123. This gave the quantities of the items required to harvest one ton. Items which were included in both growing and harvesting costs, such as human and horse labor, were added together.

TABLE 8. ESTIMATED QUANTITIES OF THE PRINCIPAL ITEMS REQUIRED TO PRODUCE ONE TON OF PEAS IN 1920 WITH A YIELD OF 1800 POUNDS PER ACRE*

(Based on data from 262 farms)

Item	Quantity
Seed	4.5 bushels
Fertilizer	182.0 pounds
Manure	3.1 tons
Human labor	37.0 hours
Horse labor	65.0 hours
Use of equipment	65.0 hours
Use of land	1.1 acres

*The items included made up 97 per cent of the cost in 1920.

Seed

With the exception of human labor, seed was the largest single item in the cost of producing peas in 1920. The seed is supplied to the farmers by the canning companies. Very little of it is produced in New York State. The price of seed was higher in 1920 than the price which farmers paid the company. The difference is a part of the cost of raw product to the company. If seed cost $6 a bushel and was charged at $4, the additional cost per ton of shelled peas with a yield of 2000 pounds per acre would be $8. The canners call this item "seed loss" and recognize it as one of their costs.

This practice of not charging peas to the farmer at cost partially distributes the risk of loss in case of crop failure. Seed is not paid for when planted, but the cost is deducted from payment for the crop. In case of crop failure, the farmer usually stands the loss up to the amount at which the seed is charged to him. With seed at $4 a bushel and peas at 4 cents a pound, it required 400 pounds of shelled peas to pay for the seed. On only one of the 262 farms on which figures for the 1920 crop were obtained was the yield per acre less than 400 pounds. The seed loss per ton of peas harvested is greater in years when the average yield per acre is low than in years when the yield per acre is high, as the loss per acre is fixed.

The quantity of peas most commonly sown per acre was four bushels (table 9). In most sections the price of seed was $4 a bushel. In the Steuben area it was $3.50 a bushel. This difference in the price of seed made a difference of $2 per acre in the cost of producing peas.

TABLE 9. FARMS USING DIFFERENT QUANTITIES OF SEED PER ACRE, 262 FARMS, 1920

Bushels per acre	Number of farms					
	Orleans	Genesee	Steuben	Ontario	Other counties	Total
Less than 4	16	10	1	..	7	34
4	50	29	34	43	26	182
More than 4	10	9	18	7	2	46
Average	4.0	4.0	4.2	4.1	3.9	4.0

Fertilizer

Fertilizer was not a very large item in the cost of producing peas. The extent to which fertilizer was used is shown in table 10. The principal fertilizing material was some form of phosphorus. Practically half of all the fertilizer used was acid phosphate, and the balance was some kind of mixed fertilizer in which phosphorus was the principal constituent (table 11).

TABLE 10. USE OF FERTILIZER ON PEAS IN 1920

Area	Number of farms using fertilizer on peas	Per cent of farms using fertilizer on peas	Number of acres on which fertilizer was used	Per cent of land in peas which was fertilized	Average quantity of fertilizer used per acre fertilized (pounds)
Orleans........	73	96	363.8	97	253
Genesee.......	20	42	145.0	36	223
Steuben.......	30	57	173.0	58	213
Ontario........	47	94	147.8	82	251
Other counties..	29	83	192.8	94	216
All farms......	199	76	1,022.4	70	235

TABLE 11. KINDS AND QUANTITIES OF FERTILIZER USED ON THE 199 FARMS USING FERTILIZER ON PEAS IN 1920

Kind of fertilizer*	Number of farms using	Acres of peas on which used	Total pounds applied	Total cost	Per cent of total pounds
1-8-0...........	1	6.0	1,000	$ 17.50	0.4
1-8-1...........	2	9.2	1,840	32.37	0.8
1-8-2...........	17	82.2	19,500	381.68	8.1
1-8-3...........	2	7.0	1,400	33.60	0.6
1-8-4...........	4	15.0	3,350	72.08	1.4
1-9-0...........	1	6.0	1,000	17.50	0.4
1-9-3...........	2	3.5	618	14.22	0.3
1-10-0..........	14	64.5	14,570	248.57	6.1
1-10-1..........	4	17.0	3,650	70.10	1.5
1-10-2..........	2	13.5	2,700	53.00	1.1
1.5-10-0........	2	36.0	9,000	155.21	3.7
2-8-0...........	1	4.0	1,200	26.40	0.5
2-8-1...........	1	3.0	600	13.50	0.2
2-8-2...........	12	56.2	12,800	277.08	5.3
2-8-3...........	10	28.5	6,450	144.27	2.7
2-8-4...........	5	14.0	6,050	157.25	2.5
2-8-5...........	2	8.0	2,300	56.10	1.0
2-8-10..........	1	2.5	500	16.25	0.2
2-10-0..........	31	128.5	26,532	506.01	11.0
2-10-2..........	1	3.0	750	16.69	0.3
2-12-0..........	3	15.0	3,000	61.99	1.2
3-8-0...........	1	5.0	1,250	23.12	0.5
3-8-5...........	1	9.5	2,100	63.00	0.9
0-10-2..........	1	5.0	750	12.75	0.3
0-12-3..........	1	2.5	800	15.20	0.3
Acid phosphate...	87	477.8	116,487	1,657.77	48.7
Nitrate of soda...	1	....	25	1.10	....
Total........	210†	1,022.4	240,222	$4,144.31	100.0

* The numbers used to designate the kinds of fertilizer refer to the percentages of the three constituents, nitrogen, phosphoric acid, and potash, in the fertilizer: for example, a 1-8-2 fertilizer contains 1 per cent of nitrogen (N), 8 per cent of phosphoric acid (P_2O_5), and 2 per cent of potash (K_2O).

† Some of the 199 farms used more than one kind of fertilizer.

Manure

Three-fourths of the land on which peas were grown in 1920 had been manured during the years 1917 to 1920 (table 12). More manure had been used in the Genesee and Steuben areas than in the other areas. In these two sections the smallest quantity of fertilizer was used per acre. The manure charged to peas was applied principally to the preceding crop (table 13). Eighty-two per cent of the applications charged to the pea crop were made directly to the peas or the preceding crop.

TABLE 12. MANURE APPLIED FROM 1917 TO 1920, TO LAND IN PEAS IN 1920

Area	Acres of peas	Acres manured	Tons of manure applied	Tons charged to crop	Tons charged to crop per acre of peas
Orleans	376.7	257.4	3,249	900	2.4
Genesee	406.5	297.5	4,714	1,221	3.0
Steuben	300.0	232.8	3,429	992	3.3
Ontario	179.6	123.8	1,561	462	2.6
Other counties	205.2	162.4	2,073	521	2.5
All farms	1,468.0	1,073.9	15,026	4,096	2.8

TABLE 13. APPLICATIONS OF MANURE, BY YEARS, TO LAND IN PEAS IN 1920

Year manure was applied	Total manure applied		Manure charged to crop	
	Tons	Per cent	Tons	Per cent
1920	1,830	12.2	731	17.8
1919	8,691	57.8	2,630	64.2
1918	2,881	19.2	573	14.0
1917	1,624	10.8	162	4.0
Total	15,026	100.0	4,096	100.0

Lime

Except in the Steuben area, lime had not been used extensively on land on which peas were grown. Of 209 farms outside of that area, only 11 had used lime during the years 1916 to 1920 on the land in peas in 1920. In the Steuben area, 19 out of 53 farms had used lime during that period on the land in peas in 1920. Except in this area the soils in the areas studied are, in general, naturally well supplied with lime.

Labor

The rates for the various classes of labor that performed the work on peas in 1920 varied somewhat (table 14). The rate at which the operators' labor was charged was 9 cents higher per hour than the rate for hired labor for the growing work, and 7 cents higher for the harvesting work.

The labor rates were lowest in the Steuben area and highest in the Orleans and Genesee areas.

TABLE 14. RATES PER HOUR FOR DIFFERENT CLASSES OF LABOR ON PEAS, 262 FARMS, 1920

Class of labor	Orleans	Genesee	Steuben	Ontario	Other counties	All farms
Growing:						
Operators	$0.49	$0.50	$0.41	$0.46	$0.46	$0.47
Sons over 16	0.47	0.49	0.39	0.36	0.30	0.42
Other family	0.37	0.30	......	0.27	0.32	0.32
All family	0.48	0.49	0.41	0.44	0.44	0.46
Hired	0.41	0.43	0.33	0.36	0.38	0.39
Total growing	$0.46	$0.48	$0.38	$0.42	$0.42	$0.44
Harvesting:						
Operators	$0.48	$0.51	$0.42	$0.46	$0.46	$0.46
Sons over 16	0.43	0.49	0.40	0.36	0.37	0.42
Brothers	0.30	......	......	0.30	0.35	0.32
Fathers	0.48	0.34	0.29	0.46	......	0.38
Other family	0.34	0.29	0.31	0.27	0.38	0.31
All family	0.45	0.45	0.41	0.42	0.44	0.43
Hired	0.41	0.40	0.36	0.37	0.42	0.39
Total harvesting	$0.44	$0.44	$0.39	$0.40	$0.43	$0.42

The proportion of the work performed by these different classes of labor is shown in table 15. Seventy-one per cent of the work on the crop

TABLE 15. PROPORTION OF WORK ON PEAS PERFORMED BY DIFFERENT CLASSES OF LABOR, 262 FARMS, 1920

Class of labor	Per cent of work done					
	Orleans	Genesee	Steuben	Ontario	Other counties	All farms
Growing:						
Operators	68	64	54	57	58	61
Sons over 16	4	10	12	10	5	8
Other family	1	3	......	1	2	2
All family	73	77	66	68	65	71
Hired	27	23	34	32	35	29
Total growing	100	100	100	100	100	100
Harvesting:						
Operators	48	41	46	46	41	45
Sons over 16	6	9	7	12	6	7
Brothers	1	......	......	1	2	1
Fathers	1	4	1	1	......	2
Other family	11	12	6	7	3	8
All family	67	66	60	67	52	63
Hired	33	34	40	33	48	37
Total harvesting	100	100	100	100	100	100

before harvest was done by the operator or some member of his family. A larger proportion of the harvesting labor was hired. A considerable amount of the harvesting labor was done by sons under sixteen years of age and by wives and daughters of the farmers. The nature of the pea crop requires that it be harvested quickly. At such times extra labor must be obtained, and if hired labor is not available the work must ordinarily be performed by members of the family. Labor was particularly scarce and high during the season of 1920. This fact may have made it necessary for a larger proportion of the labor than normal to be performed by the operators' wives and children.

Miscellaneous expenses

Soil inoculation, with cultures prepared by the College of Agriculture, was used on 12 farms. The purpose of this practice is to introduce into the soil the bacteria which enable the pea plant to utilize nitrogen from the air. In most of these cases it was being tested in cooperation with either the canning factory or the farm bureau.

When a grower belonged to a growers' association, dues and commissions paid to the association were considered as costs. In the Genesee area 1 per cent of the value of the peas, less the seed, was deducted by the canning company from payments made to association members, and paid to the association. In Steuben County 0.5 per cent of the value was similarly deducted and paid to the association.

Interest

The interest item, as explained on page 7, was calculated to the date when the peas were paid for. This varied with the different factories. Dates were on which payments were to be made specified in the contract. These dates were as follows: Orleans area, at the principal factory, on the 1st of the month for all peas hauled in before the 15th of the preceding month; Genesee area, one-half when the peas were drawn in, balance on October 1; Steuben and Ontario areas, one-half on August 15, balance on November 1. In all cases the amounts due the company for seed, labor, or ensilage were deducted from the first payment. The other companies paid at various dates. In some cases no payment was made until December 1. Interest was figured on the basis of the dates specified in the contracts, because when the costs were calculated the exact dates of payment, if different, were not known.

At least one company in the State paid interest on the unpaid balance from August 25 to the date of the final payment. Farmers can usually obtain the money in advance of the contract date by discounting at their bank a non-interest-bearing note which the company will give them. This practice amounts to their paying interest on the money they receive until the date the contract calls for payment. The longer the payment is delayed, the larger the item of interest becomes and the less advantage peas have as a crop on which the farmer can realize quick returns.

Use of land

The land values and the charges for the use of land on which peas were grown in the different areas are given in table 16. The land value was

highest in the Ontario area and lowest in the Steuben area. The variations in value are due to differences in the productivity of the soil, the character of the crops grown, the location relative to markets and towns, and other local conditions.

TABLE 16. VALUE PER ACRE AND CHARGES FOR USE OF LAND IN PEAS, 262 FARMS, 1920

Area	Value per acre*	Charges per acre			
		Land owned	Land share-rented	Land cash-rented	All farms
Orleans	$115	$10.01	$ 8.65	$ 6.63	$ 9.31
Genesee	114	9.66	8.42	8.07	9.25
Steuben	93	8.20	6.40	15.00	7.73
Ontario	128	10.64	10.17	8.29	10.42
Other counties	121	10.00	10.11	....	10.00
All farms	$112	$9.62	$8.27	$8.16	$9.18

* Includes only value of land owned or worked on shares.

On a few farms a second crop was grown after the pea crop was harvested. This was most common in the Ontario area. Buckwheat, the principal crop so grown, was grown on 15 farms after 48 acres of peas. Fodder corn was grown on 2 farms after 13 acres of peas. The land was prepared for the buckwheat or the corn by disking without plowing. This practice was followed only after the early varieties of peas — Alaska and Surprise. When the land was so double-cropped, the peas were charged one-half the land cost.

The proportion of the peas grown under different tenures is shown in table 17. In calculating costs no division was made between tenant and landlord. Usually the returns from shelled peas and the expenses for seed and fertilizer are divided equally; the tenant pays all the cash cost of human labor, and the landlord all the land costs; the horse and equipment costs are divided in varying proportions between the two. Considering the pea crop alone, more than half of the costs are ordinarily borne by the tenant.

TABLE 17. PROPORTION OF ACRES OF PEAS GROWN UNDER DIFFERENT TENURES, 1920

Tenure	Per cent of acres of peas grown					
	Orleans	Genesee	Steuben	Ontario	Other counties	All farms
Owned	57	68	66	69	92	68
Worked on shares	37	26	32	26	8	28
Cash-rented	6	6	2	5	....	4
Total	100	100	100	100	100	100

RETURNS

Prices paid

In 1920 the price received was nearly uniform in the different sections. This was due in part to the activities of the growers' associations, which attempted to secure a uniform price. The prices paid per ton in the various areas were as follows: Orleans, $80 for all varieties; Genesee, $82.50 for the early varieties, and $77.50 for the late varieties except Prince of Wales, for which $82.50 was paid; Steuben, $82 for all varieties; Ontario, a variable price depending on the proportion of peas of different sizes.

Buying on a graded basis

The time when peas are harvested has much to do with the profits of both the farmer and the canner. The interest of both is to get as much money out of the crop as possible. This can be accomplished most satisfactorily to both parties by cutting the peas at as late a date as will permit their being in the tender condition necessary for high quality in the canned product. The companies usually employ "road men" to watch the peas of the different growers and order them cut when they are at the proper stage. The better and more experienced road men aim to have the peas cut at a stage when the yield will be good but the peas will still be in good condition for canning. With favorable weather they are usually successful in this.

Most of the canning companies pay a flat price per ton for peas. Sometimes the contracts call for two prices — one for fancy and one for standard peas. If the peas are cut when ordered by the company's road men, they are usually paid for as fancy peas. A few companies pay for peas according to the proportion of the different sizes. One of these is the company operating in the Ontario area. After the peas are threshed, a sample of them is mechanically graded according to size. The number of pounds of each size in 100 pounds of peas, and the price per hundred of the load, are then calculated. The prices paid in 1920 at this plant were as follows:

Alaska variety

1. 10 cents a pound for peas that went thru a 18/64-inch mesh
2. 8 cents a pound for peas that went thru a 20/64-inch mesh
3. 3 cents a pound for peas that went thru a 22/64-inch mesh
4. 2 cents a pound for peas that would not go thru a 22/64-inch mesh

Sweet Wrinkled varieties

1. 10 cents a pound for peas that went thru a 20/64-inch mesh
2. 8 cents a pound for peas that went thru a 22/64-inch mesh
3. 3 cents a pound for peas that went thru a 24/64-inch mesh
4. 2 cents a pound for peas that would not go thru a 24/64-inch mesh

If when calculated on the above basis the average price per ton was not $81.25 for the entire crop of the Alaska variety, or $76.25 for the entire crop of the Sweet Wrinkled varieties, a minimum price of $81.25 per ton was paid for the former and $76.25 for the latter.

Whether this system is as satisfactory to the farmer as the payment of a flat price depends on the comparative yields and prices under the two

systems. The yields per acre for an early and a late variety in two sections in which other conditions were similar were as follows:

Variety	Graded basis	Flat price
Alaska	1,819 pounds	1,834 pounds
Advancer	2,389 pounds	2,440 pounds
Average of all varieties	2,099 pounds	2,197 pounds

The proportions of the different sizes among all the peas threshed at two viner stations in the Ontario area, with the resulting prices per ton, are given in table 18:

TABLE 18. PROPORTIONS OF PEAS OF DIFFERENT SIZES FOR DIFFERENT VARIETIES, PRICES PAID FOR EACH SIZE, AND CALCULATED VALUE PER TON, AT TWO VINER STATIONS IN THE ONTARIO AREA, 1920

Variety and size according to preceding schedule	Pounds of each size per 100 pounds of peas	Price per pound for this size	Value
Alaska variety			
Viner station No. 1			
Size 1	8.100	$0.10	$0.81000
Size 2	19.385	0.08	1.55080
Size 3	47.019	0.03	1.41057
Size 4	25.496	0.02	0.50992
	100.000	....	$4.28129
Price per ton	$85.63		
Viner station No. 2			
Size 1	6.491	$0.10	$0.64910
Size 2	18.408	0.08	1.47264
Size 3	49.453	0.03	1.48359
Size 4	25.648	0.02	0.51296
	100.000	....	$4.11829
Price per ton	$82.37		
Sweet Wrinkled varieties			
Viner station No. 1			
Size 1	8.439	$0.10	$0.84390
Size 2	13.407	0.08	1.07256
Size 3	26.771	0.03	0.80313
Size 4	51.383	0.02	1.02766
	100.000	....	$3.74725
Price per ton	$74.94		
Viner station No. 2			
Size 1	9.898	$0.10	$0.98980
Size 2	14.828	0.08	1.18624
Size 3	29.111	0.03	0.87333
Size 4	46.163	0.02	0.92326
	100.000	....	$3.97263
Price per ton	$79.45		

The prices per ton as calculated in table 18 are not the actual prices paid but are the prices that would have been paid if no minimum price per ton had been guaranteed. With a minimum price per ton guaranteed, the prices actually paid were higher. The average prices paid on the 50 farms in this section on which cost figures were obtained were as follows: Alaska variety, $86.34 per ton; Horsford Market Garden variety, $79.72 per ton; Advancer variety, $82.32 per ton. The larger proportion of large-sized peas in the Horsford Market Garden variety resulted in a lower average price per ton than for the Advancer variety.

The farms with the lower yields received higher average prices per ton (table 19). The higher prices received on the farms which had the lower average yields indicate that a larger proportion of the peas on these farms were of the smaller sizes. However, there were some farms in the higher-yielding groups which produced peas that graded well enough so that the price paid was higher than the guaranteed price. This was true of the farms that had good yields of the Alaska and Advancer varieties. Only one farmer out of ten having a yield of over 2500 pounds of the Horsford Market Garden variety received a premium, while seven farmers out of eleven that had yields of over 2500 pounds of the Advancer variety received higher than the guaranteed price. In order to have the same price per ton for these two varieties, a different scale of prices would be necessary.

TABLE 19. RELATION BETWEEN YIELD PER ACRE AND PRICE PER TON ON FARMS IN THE ONTARIO AREA, 1920

Yield per acre (pounds)	Acres	Average yield per acre (pounds)	Price per ton*	Number of farms	Number with price above guarantee
Alaska					
Less than 1500	22.9	1,190	$93.64	14	9
1500 to 2000	31.0	1,767	83.46	14	8
2001 to 2500	31.5	2,151	86.48	14	7
Over 2500	5.0	2,932	82.52	3	1
Total	90.4	1,819	$86.34	45	25
Advancer					
Less than 1800	6.5	1,284	$91.46	5	5
1800 to 2500	17.0	2,005	85.48	10	6
2501 to 3000	9.0	2,637	78.62	5	4
Over 3000	8.8	3,669	79.32	6	3
Total	41.3	2,389	$82.32	26	18
Horsford Market Garden					
Less than 1800	13.9	1,553	$84.78	9	7
1800 to 2500	12.5	2,007	85.06	8	6
2501 to 3000	7.0	2,579	73.96	5	1
Over 3000	11.5	3,453	76.22	5	0
Total	44.9	2,326	$79.72	27	14

* If the amounts paid as guarantees were not included in these returns, the differences in the price per ton between groups would be even greater.

Miscellaneous returns

The pea crop yields two products, peas and vines. The vines, after being threshed, usually are stacked. At a few factories they are put into silos. The outside of the stack rots, shutting out the air, and the interior becomes ensilage. This is usually sold back to the growers. The prices charged and the quantities allowed the growers vary considerably in the different areas. The ensilage is usually divided among the growers according to the acreage grown or the weight of shelled peas delivered. Ordinarily about two tons of ensilage are returned per acre. Frequently the owner of the land on which an outlying viner station is located receives, without cost or at a nominal sum, a considerable proportion of the ensilage. He usually grows a considerable acreage of peas.

In figuring the net cost of shelled peas, the estimated value of the vines above the charge made by the canner and the cost of hauling was deducted from the total cost of the crop. None of the regions included in the survey are important livestock regions, livestock being kept principally to utilize by-product roughage. The pea-vine ensilage is fed chiefly to dairy cattle and to sheep. In counties where dairying is more important, the ensilage would be a larger item of credit to the crop than in the areas included in this study. In dairy sections the green vines are often drawn home as they come from the viner, and fed to the stock. No charge is made for these ordinarily.

Factors affecting net returns

Other factors than price must be considered in comparing payments made by different companies. The more important of these are: (1) The price at which seed is charged. With a crop of 1800 pounds per acre, a change of $1 per bushel in the price of seed is equal to a change of about $4.50 per ton in the price of the peas. (2) The practice of the companies as to weighing. Some companies weigh the peas as they come from the viner without cleaning, others partly clean them, and others clean thoroly with a blower-cleaner before weighing. (3) The price at which the growers are allowed to purchase ensilage. If two tons of ensilage are

TABLE 20. NUMBER OF ACRES, AND YIELDS OF SHELLED PEAS PER ACRE, OF VARIETIES OF PEAS GROWN

Variety	On 76 farms in the Orleans area		On 48 farms in the Genesee area		On 53 farms in the Steuben area		On 50 farms in the Ontario area		On 262 farms in all regions
	Acres	Pounds per acre	Acres	Pounds per acre	Acres	Pounds per acre	Acres	Pounds per acre	Pounds per acre
Alaska	165.6	1,695	93.0	1,834	81.2	1,989	90.4	1,819	1,808
Surprise	4.5	1,676	31.0	1,623	4.0	1,803	.....	......	1,671
Roger's No. 60	.....	......	29.0	2,049	.....	......	.....	......	2,049
Admiral, green	127.2	2,342	67.5	2,820	48.3	2,992	.....	......	2,587
Admiral, yellow	.....	......	.....	......	15.7	3,345	.....	......	3,345
Advancer	7.5	2,997	94.6	2,440	.....	......	41.3	2,389	2,710
Improved Advancer	.....	......	23.0	2,391	.....	......	.....	......	2,391
Little Gem	.....	.....	.....	......	17.9	3,350	.....	......	3,350
Horsford Market Garden	.....	......	47.2	1,861	51.5	2,583	44.9	2,326	2,260
Prince of Wales	4.3	1,772	14.2	2,343	.....	......	.....	......	2,210
Rice's No. 13	24.5	1,823	.....	......	16.2	2,841	3.0	3,162	2,295
Unclassified	43.1	......	7.0	......	65.2	......	.....	......	....
All varieties	376.7	1,971	406.5	2,197	300.0	2,633	179.6	2,099	2,246

returned to the acre, a difference of $2 in the price at which ensilage is charged to the farmer would be equal to a change of about $4 per ton in the price of the shelled peas. (4) The requirements regarding the quality of peas when harvested. (5) The proportion of the different varieties in the total acreage. The acreages and yields of the varieties grown in each area are shown in table 20. The lower average yield in the Orleans area was due partly to the large proportion of the acreage which was given to the Alaska variety. The higher yield for all varieties in the Steuben area was due in part to the practice of allowing the peas to become more mature before harvesting. The peas in this area were also weighed before being cleaned. The prices paid in 1920 did not take sufficient account of these factors.

Return per hour of labor

The good yield per acre and the prices received for peas made them a profitable crop in 1920 (table 21). The estimated cost per ton of shelled peas in 1920 with a yield of 1800 pounds per acre, was $73.66 (table 7, page 18). With this yield there would have been a profit of about 19 cents per hour of labor, or a return of about 62 cents.

TABLE 21. RETURN PER HOUR OF LABOR ON PEAS, ON 262 FARMS IN 1920

	Orleans	Genesee	Steuben	Ontario	Other counties	All farms
Return per hour*.....	$0.69	$1.00	$1.17	$0.79	$1.37	$0.98
Cost per hour........	0.45	0.46	0.39	0.41	0.42	0.43
Profit per hour.......	$0.24	$0.54	$0.78	$0.38	$0.95	$0.55

* The return per hour is calculated by adding to the profit the cost of labor, and dividing by the total hours worked.

The return per hour of labor is one measure by which comparisons may be made between crops. Other factors also must be considered. The more important of these are: competition with other crops for labor or for land; and effect on the yields of other crops in the rotation.

Competition with other crops for labor.—Crops should be grown that will most profitably utilize the available men, horses, and equipment. A crop that yields a low return on the labor may be grown if it keeps men and teams busy at a time when they would otherwise be idle. Similarly, a crop on which work must be done at a time when men and teams can profitably be employed on other crops, must yield a return comparable with the returns from the competing crops. The important competition in the case of peas comes at harvest time. The date of harvesting varies with the season, the variety, and the location. In 1920 it commenced in the latter part of June for the Alaska and other early varieties, and finished about the first of August for the later varieties. This is one of the busiest seasons of the year on most farms in the pea-producing sections. The farmers were asked the question, "With what other farm operations did work on peas conflict?" The most frequent answers to this question were: none, 117; haying, 75; haying and cultivating, 23; haying and wheat harvest, 13; cultivating, 6; wheat harvest and cultivating, 4. The

conflict with cultivating came principally in the Steuben area, with the potato crop. To compete with these crops the returns per hour must be good.

Competition with other crops for land.—The basis of most systems of crop production is a rotation of some sort. The competition for land is between crops that fit equally well into the rotation. The commonest rotation in which peas are grown in the areas studied is: (1) a cultivated crop; (2) peas, beans, oats, or barley; (3) winter wheat; (4) hay. Each farmer was asked what crop he would have grown on the same land if he had not grown peas. The most frequent answers to this question were: oats, 70; barley, 37; oats or barley, 47; beans, 18; hay, 8; cabbage, 10; potatoes, 7. Oats and barley are both crops which normally yield low returns. In 1920 beans were an uncertain crop.

Peas are used also as a crop with which to seed hay or alfalfa. This practice is commonest in the pea-growing sections where wheat is not an important crop. Barley or oats are ordinarily used to seed with in these sections if peas are not grown. The competition for land is less important than the competition for labor.

Effect on the yields of other crops in the rotation.—The opinion is generally held by farmers that wheat yields are better after peas than after oats or barley. Increases in yields of wheat when grown following peas, over the yields of wheat following other crops, according to estimates of the farmers, are given in table 22. If the land on which peas are grown can be worked immediately after the peas are harvested, it may be fitted for wheat without plowing. However, because of other work at this season, it is not usually possible to do this, and it is then necessary to plow and fit the land in the usual manner.

TABLE 22. YIELD OF WHEAT PER ACRE IN RELATION TO THE PRECEDING CROP GROWN

Crop preceding wheat	Number of estimates	Increased yield of wheat after peas, over yield after other crops
Oats	129	5.5 bushels
Barley	93	4.0 bushels
Beans	33	3.7 bushels

VARIATIONS IN THE COST OF PRODUCING PEAS

When the cost-of-production data of any commodity are studied, it is found that there are wide variations in the cost per unit for different producers. The range of costs of producing peas on 262 farms in 1920 is given in table 23.

The average cost of production of peas was $62 a ton, and the cost below which 85 per cent of the crop (tons) was produced was about $75. The average price received for peas was $80.44 per ton. Approximately 90 per cent of the crop was produced at a cost below this. This range of costs is for a year when the yield was higher than the average yield over a period of years. If the yield per acre had been 1800 pounds, the

TABLE 23. RANGE OF COSTS OF PRODUCING PEAS ON 262 FARMS IN 1920

Cost per ton	Average cost per ton	Number of farms	Per cent of total farms	Per cent of farms at this cost or lower	Acres	Per cent of total acres	Per cent of acres at this cost or lower	Tons	Per cent of total tons	Per cent of tons at this cost or lower	Yield per acre (tons)
$ 30–$ 40	$ 36	11	4.2	4.2	107.0	7.3	7.3	177.4	10.8	10.8	1.658
40– 50	45	40	15.3	19.5	235.0	16.0	23.3	330.6	20.1	30.8	1.407
50– 60	54	43	16.4	35.9	267.2	18.2	41.5	343.8	20.8	51.7	1.287
60– 70	65	51	19.5	55.3	302.0	20.6	62.1	330.1	20.0	71.7	1.093
70– 80	75	44	16.8	72.1	246.0	16.7	78.8	220.6	13.4	85.1	0.897
80– 90	85	22	8.4	80.5	143.3	9.8	88.6	129.7	7.9	93.0	0.905
90– 100	95	14	5.3	85.9	49.5	3.4	92.0	40.1	2.4	95.4	0.810
100+	119	37	14.1	100.0	118.0	8.0	100.0	75.9	4.6	100.0	0.643
All farms	$62	262	100.0	....	1,468.0	100.0	....	1,648.2	100.0	....	1.123

average price received would have covered the cost of producing about 75 per cent of the total crop.

In spite of poor yields obtained in 1919, the acreage of peas grown in 1920 was 16 per cent above the yearly average grown from 1917 to 1920 (table 24). The acreage figures are from reports of the United States Department of Agriculture.

TABLE 24. ACRES OF SELECTED CROPS GROWN IN NEW YORK STATE FROM 1917 TO 1920

Year	Peas		Oats		Potatoes		Winter wheat		Tomatoes	
	Acres	Per cent of average 1917–1920	Acres	Per cent of average 1917–1920	Acres	Per cent of average 1917–1920	Acres	Per cent of average 1917–1920	Acres	Per cent of average 1917–1920
1917	19,283	83	1,275,000	106	400,000	106	430,000	99	8,584	92
1918	24,203	105	1,260,000	105	380,000	100	380,000	87	10,986	118
1919	22,151	96	1,120,000	93	363,000	96	474,000	109	7,807	84
1920	26,749	116	1,150,000	96	370,000	98	460,000	106	9,837	106
Average	23,096	100	1,201,250	100	378,250	100	436,000	100	9,304	100

The question was asked of each grower, "If prices and costs are the same as this year [1920], will you grow peas next year?" A summary of the answers to this question among the groups of farmers having different costs, shows that the proportion of growers not planning to grow peas in 1921 increased as the cost per ton in 1920 increased (table 25).

TABLE 25. COST PER TON IN 1920 ON 262 FARMS, AND NUMBER OF FARMERS NOT PLANNING TO GROW PEAS IN 1921

Cost per ton in 1920	Number of farms	Number not planning to grow peas in 1921	Per cent of farms in group
Less than $40	11	0	0
$ 40–$ 50	40	2	5
50– 60	43	4	9
60– 70	51	9	18
70– 80	44	8	18
80–100	36	8	22
100+	37	14	38
All farms	262	45	17

By the method of calculating costs used in this study, even if a grower failed to receive returns that paid all costs he might still have received some returns for his labor and some interest. The question whether or not he should grow peas depends on whether he has an alternative that would give greater returns. Even if the returns are sufficient to pay a profit above all costs, they may not be as good as could be received from some alternative. In such a case peas would not be grown.

LABOR REQUIREMENTS

The land is plowed and fitted until a good seedbed is prepared, spring-tooth and disk harrows and rollers being used according to the nature of the soil. The peas are planted with a grain drill. In practically all cases the land is rolled after the peas have been drilled. This is done to firm the soil around the seed, and also to smooth the land as much as possible to facilitate harvesting. The average hours required to perform the various operations are given in table 26. The hours given are not the average time for those doing the work, but were obtained by dividing the total number of hours spent on the operation by the total number of acres. The average hours required for performing a particular operation once may be obtained by dividing the average hours as given, by the number of times the operation was performed.

TABLE 26. AVERAGE HOURS PER ACRE REQUIRED TO PERFORM VARIOUS OPERATIONS ON THE PEA CROP ON 262 FARMS GROWING 1468 ACRES IN 1920

Operation	Number of times operation was performed	Man hours	Horse hours	Tractor hours
Plowing	1.0	5.7	14.0	0.1
Harrowing	3.5	3.5	9.8	0.1
Disking	0.4	0.4	1.0	0.1
Rolling before drilling	1.2	0.8	1.8	....
Cultipacking	0.2	0.2	0.5	....
Hauling fertilizer	....	0.2	0.5	....
Hauling seed	....	0.4	0.8	....
Drilling	1.0	1.3	2.6	....
Rolling after drilling	1.0	0.8	1.6	....
Harrowing after drilling	....	0.1	0.2	....
Hauling and spreading manure	....	2.3	4.6	....
Hauling and spreading lime	....	0.1	0.1	....
Total	....	15.8	37.5	0.3

The methods of fitting in the Orleans, Genesee, and Ontario areas were similar. The man hours per acre were lower, and the horse hours were higher, in the Genesee area than in the other sections (table 27). This was due partly to the practice of driving more horses per man in the Genesee area, thereby increasing the amount of work done per man in a day. Also, larger acreages of peas were grown per farm in the Genesee area, which might be expected to reduce the hours spent per acre. In the Steuben area the land is stonier than in the other areas and more time was required to plow an acre. After the land was plowed, however, less time was spent to prepare it for drilling. The only tillage that most of the land received was harrowing from two to four times. On a few farms in one locality of this area, peas were planted after potatoes without plowing. The yields on these farms were as good as the average of the region. This was done only on a loose, light soil that had been well tilled the previous year.

TABLE 27. AVERAGE LABOR REQUIREMENTS PER ACRE GROWING PEAS ON 262 FARMS IN 1920

	Orleans	Genesee	Steuben	Ontario	Other counties	All farms
Man hours per acre....	17.2	15.0	16.3	15.9	14.2	15.8
Horse hours per acre...	37.8	41.7	35.7	34.3	34.2	37.5
Tractor hours per acre.	0.4	0.2	0.3	0.7	0.4	0.3
Acres per farm........	5.0	8.5	5.7	3.6	5.9	5.6

Peas are usually harvested with a mowing machine fitted with some special attachments. Special machines have been designed for harvesting peas, but they are not in general use in New York. The peas, after being cut, are bunched, loaded on hay racks, and drawn to the factory or the viner station. Since they are cut when green, they are bulky and heavy. The variations in the time required to harvest peas in the different areas are shown in table 28:

TABLE 28. AVERAGE LABOR REQUIREMENTS PER ACRE HARVESTING PEAS ON 262 FARMS IN 1920

	Orleans	Genesee	Steuben	Ontario	Other counties	All farms
Man hours per acre....	21.4	16.4	29.7	24.2	19.9	21.8
Horse hours per acre...	25.3	22.3	35.2	28.1	21.2	26.2
Man hours per ton....	21.7	14.9	22.6	23.0	16.5	19.5
Horse hours per ton...	25.7	20.3	26.7	26.8	17.6	23.4
Tons per acre.........	1.00	1.10	1.32	1.05	1.20	1.12
Miles to viner.........	2.3	2.2	2.3	1.4	1.3	2.0
Acres per farm........	5.0	8.5	5.7	3.6	5.9	5.6

Variations in the length of time required to harvest, other than those due to differences in efficiency on different farms, may be due to a number of causes. Some of these are:

1. Variations in topography. On land which is fairly level and free from stones, the peas can be harvested more rapidly than on land which is more hilly or stony.

2. Differences in acreages of peas per farm and in length of haul to the viner. The farmers growing the larger acreages, or whose farms are nearer the viner station, harvest and haul peas in less time than is required by growers with smaller acreages or with longer hauls.

3. Delay in unloading peas at the factory. At most plants the farmers unload the peas along conveyers which run to the viners. The employees of the factory take care of them after this. At the plants located in the Steuben area, each man waited until his load could be threshed, and then pitched it to the viner directly. In this area the growers estimated that, on the average, about 3.2 hours per acre, or a little less than an hour per load, were lost in waiting to unload. Very few of the farmers in the other areas reported any delays in unloading.

4. Use of labor-saving attachments. There are two types of attachments that are put on an ordinary mowing machine in order that peas may be harvested more efficiently: "lifters," or long guards put on in place of the regular guards at intervals of one foot, which raise the peas so that they can be more easily cut; and "windrowers," or "swathers," which are curved metal bands fastened to the cutter bar to roll the peas back after they are cut. It is usually necessary to have men follow the machine to roll the peas back as they are being cut, so that they are not run over by the machine the next time around. The windrowers aid in this operation and shorten the time required to harvest peas (table 29).

TABLE 29. TYPE OF MACHINE USED IN HARVESTING PEAS, AND HOURS PER ACRE SPENT IN HARVESTING, ON ORLEANS, GENESEE, AND STEUBEN FARMS IN 1920

Type of machine used	Number of farms	Average distance to viner (miles)	Acres of peas per farm	Yield of peas per acre (pounds)	Hours per acre harvesting peas	
					Man	Horse
Mowing machine with windrower...........	69	2.0	8.0	2,294	18.4	24.7
Mowing machine without windrower.......	76	2.6	4.7	2,174	24.9	29.7

A number of farmers used an old mowing machine to cut peas. This operation is hard on a mowing machine. On 48 farms out of 228 on which this information was obtained, a mowing machine was used for no other purpose, while on 180 farms the same machine was used that was used in haying.

FACTORS AFFECTING THE COST OF PRODUCTION OF PEAS

Yield per acre

The cost per ton of peas is very closely related to the yield per acre. The effect of the yield on returns is shown in table 30. The costs in detail of producing peas on farms with different yields per acre are given in table 31.

TABLE 30. RELATION BETWEEN YIELD PER ACRE AND COST OF PRODUCTION OF PEAS 262 FARMS, 1920*

Yield per acre (pounds)	Number of farms	Average yield per acre (pounds)	Average growing cost per acre	Increase in growing cost per acre over lowest-yielding group	Return or loss per acre above or below cost of harvesting	Increase in return per acre above cost of harvesting, over group with lowest yield per acre
Less than 1800.	81	1,492	$52	....	-$ 4	....
1800–2500.....	101	2,138	54	$2	16	$20
Over 2500.....	80	2,988	54	2	48	52

* The correlation coefficient between the yield per acre and the cost per ton was extremely high, being −0.724 ± 0.02.

TABLE 31. AVERAGE COST OF PRODUCING AN ACRE OF PEAS ON FARMS WITH DIFFERENT YIELDS PER ACRE, 1920

Item	Yield less than 1800 pounds per acre, 81 farms, 408 acres, averaging 1492 pounds per acre		Yield 1800 to 2500 pounds per acre, 101 farms, 564 acres, averaging 2138 pounds per acre		Yield over 2500 pounds per acre, 80 farms, 496 acres, averaging 2988 pounds per acre	
	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre
Seed	4 bu.	$15.78	4 bu.	$15.90	4 bu.	$15.49
Fertilizer	139 lbs.	2.35	161 lbs.	2.80	187 lbs.	3.23
Manure charged to peas	2.4 tons	4.72	2.9 tons	6.05	3.0 tons	6.00
Lime charged to peas	41 lbs.	0.08	62 lbs.	0.11	49 lbs.	0.10
Labor growing peas:						
Human	15.8 hrs.	7.04	16.1 hrs.	7.05	15.6 hrs.	6.70
Horse	36.7 hrs.	8.99	36.8 hrs.	9.02	39.0 hrs.	9.55
Use of equipment	36.7 hrs.	3.01	36.8 hrs.	3.02	39.0 hrs.	3.20
Use of tractor	....	0.80	....	0.72	....	0.33
Use of automobile and truck	....	0.03	....	0.04	....	0.03
Miscellaneous growing expenses	....	0.06	....	0.02	....	0.07
Interest on growing costs	....	0.62	....	0.62	....	0.59
Use of land	....	8.64	....	9.02	....	9.13
Total growing cost	....	$52.12	....	$54.37	....	$54.42
Labor harvesting peas:						
Human	17.4 hrs.	$7.25	22.2 hrs.	$9.27	25.1 hrs.	$10.43
Horse	21.7 hrs.	5.32	26.4 hrs.	6.46	29.9 hrs.	7.32
Use of equipment	21.7 hrs.	1.79	26.4 hrs.	2.16	29.9 hrs.	2.45
Use of automobile, truck, and tractor	....	0.03	....	0.12	....	0.35
Miscellaneous harvesting expenses	....	0.22	....	0.30	....	0.55
Interest on harvesting costs	....	0.19	....	0.23	....	0.19
Total harvesting cost	....	$14.80	....	$18.54	....	$21.29
Total cost of crop	....	$66.92	....	$72.91	....	$75.71
Value of ensilage	....	2.05	....	$2.99	....	3.01
Net cost of shelled peas	....	$64.87	....	$69.92	....	$72.70
Shelled peas sold to factory	0.746 ton	$60.72	1.069 tons	$85.50	1.494 tons	$120.42
Price received per ton	....	81.39	....	79.98	....	80.60
Cost per ton growing	....	$69.87	....	$50.86	....	$36.43
Cost per ton harvesting	....	19.84	....	17.34	....	14.25
Net cost per ton	....	$86.96	....	$65.41	....	$48.66
Return per hour of human labor	....	$0.31	....	$0.83	....	$1.59

The number of farms with yields of less than 1800 pounds per acre was practically the same as the number having yields of 2500 pounds and more per acre. However, only 40 per cent as many tons were produced on the farms with the lower yields (table 32).

TABLE 32. PROPORTION OF PEAS PRODUCED ON FARMS WITH DIFFERENT YIELDS PER ACRE, 262 FARMS, 1920

Yield per acre (pounds)	Number of farms	Per cent of total farms	Number of acres	Per cent of total acres	Number of tons	Per cent of total tons
Less than 1800	81	31	408	28	304	18
1800–2500	101	38	564	38	603	37
Over 2500	80	31	496	34	741	45
All farms	262	100	1,468	100	1,648	100

A number of factors influence the yield per acre. Some of these, such as sowing at the proper time, the quality of the seed when the seed is charged to the farmer at a uniform price, and weather conditions, will not influence the cost of production. Other factors, such as the quantity of seed and fertilizer used per acre, will increase the cost. Whether or not any single factor is profitable depends on whether the value of the increased yield is greater than the cost of the practice.

Acres of peas per farm

Most of the growers raised small acreages of peas (table 33). Peas must be harvested within a limited time, because of the deterioration in quality if they are not cut at the proper stage of growth. The acreage that can be grown per farm may be enlarged by increasing the amount of help available or by extending the period of time in which the peas may be harvested. Additional help may be secured by hiring additional men or teams or by exchanging work with neighbors. The canning companies often furnish men and teams to the larger growers. The current rates are usually charged for these men and teams, but in some cases the charge is only nominal. The period in which peas must be harvested may be lengthened by growing a number of varieties that ripen at different dates, by making several sowings of the same variety, and by not maintaining strict standards as to the quality of the peas when harvested.

TABLE 33. FARMS GROWING DIFFERENT ACREAGES OF PEAS IN EACH AREA IN 1920

Acres of peas per farm	Orleans	Genesee	Steuben	Ontario	Other counties	All farms
1	1	2	2	5	1	11
2	17	3	7	16	8	51
3	13	....	5	13	5	36
4	12	5	5	4	8	34
5	10	4	8	5	3	30
6	10	7	13	2	4	36
7	4	3	2	1	....	10
8	2	3	5	2	1	13
9	1	5	....	1	....	7
10	2	3	2	....	....	7
11	....	4	3	....	2	9
12	....	3	....	....	1	4
13	....	1	....	....	....	1
14	1	1	....	....	....	2
15	2	1	....	....	....	3
16	....	1	1	1	....	3
22	1	....	....	....	1	2
23	....	1	....	....	....	1
34	....	1	....	....	1	2
Total	76	48	53	50	35	262
Acres per farm	5.0	8.5	5.7	3.6	5.9	5.6

While the growers raising small acreages were the most numerous, a comparatively small number of those who raised larger acreages produced a considerable proportion of the total crop (table 34). Ten per cent of

TABLE 34. PROPORTION OF PEAS PRODUCED ON FARMS GROWINC DIFFERENT ACREAGES, 262 FARMS, 1920

Acres of peas per farm	Number of farms	Per cent of farms	Acres of peas	Per cent of acres	Tons of peas	Per cent of tons
Less than 6	162	61.8	523	35.6	559	33.9
6–10	73	27.9	528	36.0	600	36.4
Over 10	27	10.3	417	28.4	489	29.7
All farms	262	100.0	1,468	100.0	1,648	100.0

the growers raised about 30 per cent of the total crop. The acres grown per farm did not affect the cost per acre before harvest (table 35). However, the cost of harvesting was considerably less on farms growing larger acreages. This was in spite of the fact that these farms had higher yields than the farms in the other groups. Part of this lower cost is due to the larger acreages grown on farms nearer to the viner. The better yield per acre secured on the farms growing the larger acreages was probably one of the chief reasons why peas were so extensively grown.

TABLE 35. RELATION BETWEEN ACRES OF PEAS PER FARM AND COST OF PRODUCTION, 262 FARMS, 1920

Acres of peas per farm	Number of farms	Average number of acres per farm	Average yield per acre (pounds)	Cost per acre		Total cost		Average distance to viner (miles)
				Growing	Harvesting	Per acre	Per ton	
Less than 6	162	3.2	2,136	$55	$21	$76	$71	2.3
6–10	73	7.2	2,274	53	19	72	63	2.2
Over 10	27	15.4	2,346	54	15	69	59	1.5
All farms	262	5.6	2,246	$54	$18	$72	$64	2.0

Distance to viner

Nearly one-fourth of the peas were grown on farms that were less than one mile from the viner, and only a little over one-fourth on farms three miles or more from the viner (table 36). The ratio between the weight of shelled peas and the weight of peas and vines as they are hauled in to be threshed varies with the variety and the yield per acre. In 1920, with a good yield of peas, the weight of shelled peas was from 15 to 20 per cent of the weight of peas and vines. A ton of peas and vines would be worth $16 if shelled peas were worth 4 cents a pound and the yield of shelled peas were 20 per cent of the weight of peas and vines. A crop that is worth no more than this per ton is too bulky to be hauled far in a busy season. The tendency therefore is to produce peas close to the

factory or the viner. The nearer the farms were located to the viner, the lower was the cost of harvesting (table 37).

TABLE 36. PROPORTION OF PEAS PRODUCED ON FARMS AT DIFFERENT DISTANCES FROM THE VINER, 262 FARMS, 1920

Distance to viner (miles)	Average distance (miles)	Number of farms	Per cent of total farms	Number of acres	Per cent of total acres	Number of tons	Per cent of total tons
Less than 1	0.44	47	17.9	336.8	22.9	393	23.8
1–1.9	1.28	74	28.3	402.2	27.4	472	28.6
2–2.9	2.20	61	23.3	317.3	21.6	342	20.8
3–3.9	3.12	38	14.5	205.2	14.0	225	13.7
4 and over	4.70	42	16.0	206.5	14.1	216	13.1
All farms	2.00	262	100.0	1,468.0	100.0	1,648	100.0

TABLE 37. RELATION BETWEEN DISTANCE TO VINER AND COST OF PRODUCTION OF PEAS, 262 FARMS, 1920

Distance to viner (miles)	Average distance (miles)	Acres of peas per farm	Average yield per acre (pounds)	Cost per acre			Hours per acre harvesting		Charge per acre for use of land
				Growing	Harvesting	Total	Man	Horse	
Less than 1	0.44	7.2	2,232	$53	$14	$67	18.3	19.6	$9.93
1–1.9	1.28	5.4	2,348	56	18	74	21.6	25.0	9.42
2–2.9	2.20	5.2	2,156	54	19	73	21.9	27.9	8.66
3–3.9	3.12	5.4	2,190	54	20	74	24.1	29.1	8.13
4 and over	4.70	4.9	2,096	52	23	75	25.9	26.2	7.71
All farms	2.00	5.6	2,246	$54	$18	$72	21.8	26.2	$8.95

COMPARISON OF DATA OBTAINED BY THE ACCOUNTING AND SURVEY METHODS

On page 5 it is stated that the data were obtained by two methods — the survey and the accounting. The detailed costs of production for the farms on which the costs were obtained by each method are given in table 38. The average cost per acre was substantially the same in both groups of farms. The average yield per acre was higher on the farms that kept accounts. This made a lower cost per ton.

Cost figures obtained exclusively by accounts represent a selected group of farms and do not represent average conditions. Accounts are very useful in cost work, principally because they give the farmer himself more confidence in the figures. However, if the object is to determine average costs, the survey method will give the required information more accurately than will the account method.

TABLE 38. AVERAGE COST OF PRODUCING AN ACRE OF PEAS IN 1920 ON FARMS ON WHICH ACCOUNTS WERE KEPT ON THE CROP, AND ON FARMS ON WHICH COST FIGURES WERE OBTAINED BY THE SURVEY METHOD

Item	Accounts — 56 farms, 348.8 acres, averaging 2494 pounds per acre		Records — 206 farms, 1119.2 acres, averaging 2168 pounds per acre	
	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre
Seed	4 bu.	$15.60	4 bu.	$15.74
Fertilizer	202 lbs.	3.28	152 lbs.	2.68
Manure	2.9 tons	6.16	2.8 tons	5.51
Lime	37 lbs.	0.10	56 lbs.	0.10
Labor growing peas:				
Human (charged to peas)	15.8 hrs.	6.68	15.9 hrs.	7.01
Horse (charged to peas)	36.6 hrs.	8.97	37.8 hrs.	9.26
Use of equipment	36.6 hrs.	3.00	37.8 hrs.	3.10
Use of tractor		0.79		0.55
Use of automobile and truck		0.07		0.03
Miscellaneous growing expenses		0.09		0.03
Interest on growing costs		0.62		0.61
Use of land		9.04		8.93
Total growing cost		$54.40		$53.55
Labor harvesting peas:				
Human	23.7 hrs.	$10.20	21.3 hrs.	$8.76
Horse	26.8 hrs.	6.58	26.1 hrs.	6.39
Use of equipment	26.8 hrs.	2.21	26.1 hrs.	2.14
Use of automobile, truck, and tractor		0.32		0.13
Miscellaneous harvesting expenses		0.34		0.37
Interest on harvesting costs		0.20		0.20
Total harvesting cost		$19.85		$17.99
Total cost of crop		$74.25		$71.54
Miscellaneous receipts		2.36		2.85
Net cost of shelled peas		$71.89		$68.69
Shelled peas sold to factory	1.247 tons	$99.61	1.084 tons	$87.53
Price received per ton		79.88		80.75
Cost per ton		$57.65		$63.37

TOMATOES

The raising of tomatoes on a scale necessary for commercial canning is limited in New York State to those parts of the State having an average growing season between killing frosts of from 160 to 170 days or longer. Outside of the lower Hudson Valley, where tillable land is limited, and Long Island, where land suited for tomato production is utilized for truck crops for sale in cities, the only section having a growing season of this length is a belt extending along Lakes Ontario and Erie (fig. 3). The protection

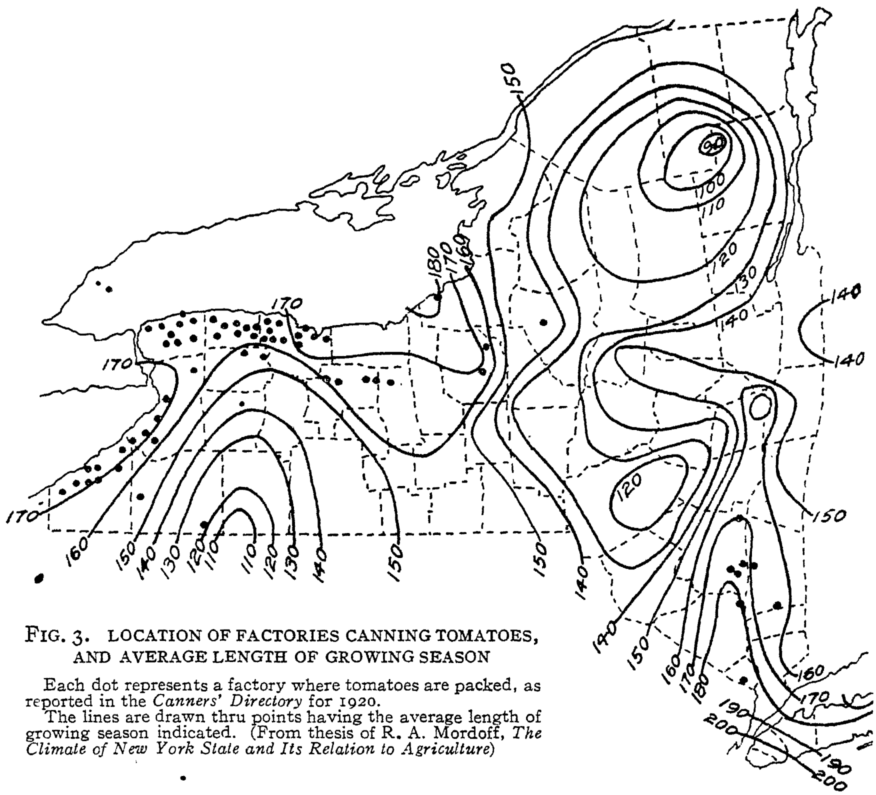

FIG. 3. LOCATION OF FACTORIES CANNING TOMATOES, AND AVERAGE LENGTH OF GROWING SEASON

Each dot represents a factory where tomatoes are packed, as reported in the *Canners' Directory* for 1920.
The lines are drawn thru points having the average length of growing season indicated. (From thesis of R. A. Mordoff, *The Climate of New York State and Its Relation to Agriculture*)

from frost which these lakes give, makes a growing season long enough so that tomatoes can be grown safely.

Data on the cost of producing tomatoes were obtained by both the survey and the accounting method in three areas — Orleans County, Niagara County, and Chautauqua and Erie Counties. The last-named section is designated in the following discussion as the Chautauqua area. The location of these areas is shown in figure 4. The number of farms on which cost figures were obtained by each method is given in table 39:

TABLE 39. Farms on Which Cost Figures on Tomatoes Were Obtained in 1920

Area	Accounts	Records	Total
Orleans	12	37	49
Niagara	6	37	43
Chautauqua	8	33	41
All farms	26	107	133

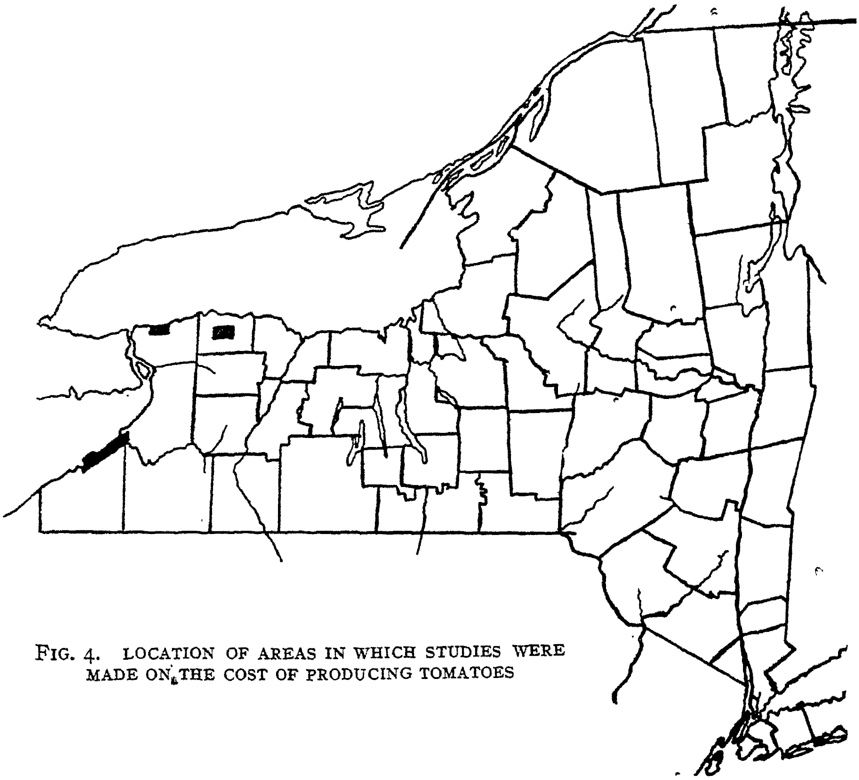

FIG. 4. LOCATION OF AREAS IN WHICH STUDIES WERE MADE ON THE COST OF PRODUCING TOMATOES

AGRICULTURAL CONDITIONS IN THE AREAS STUDIED

Orleans area

The greater part of the tomatoes grown in Orleans County are taken by local factories, which are situated in all the larger villages. The average number of days between killing frosts is from 160 to 170. This is due to the proximity of Lake Ontario. There is no soil survey of Orleans County, but the soils on which tomatoes are grown would probably be classed chiefly as Ontario loam, silt loam, and fine sandy loam, Lockport stony clay loam, and Dunkirk gravelly sandy loam. The last-named is located along the ridge road. This county is in the Lake Ontario fruit belt. Apples are the most important crop. Hay, winter wheat, pears, and peaches also are important, and a variety of other crops are grown (table 40).

Niagara area

Tomatoes are grown thruout most of the northern part of Niagara County. There are several factories that pack tomatoes in this county. One of the centers of heaviest production is the township of Wilson. The Niagara Preserving Company operates a factory in the village of Wilson, which is also one of the principal loading points for tomatoes to be shipped

to the Curtice Brothers Company's plant in Rochester. Most of the farms visited in Niagara County were in this vicinity. The township borders on Lake Ontario. The protection against frost is probably better in this locality than in the Orleans area. The land in this section is nearly level. The soils are chiefly Clyde loam and fine sandy loam, and Dunkirk loam and fine sandy loam.

TABLE 40. CROPS GROWN IN 1920 ON FARMS FOR WHICH COST DATA ON TOMATOES WERE OBTAINED

Crop	Acres per farm			Per cent of total crop acres		
	Orleans	Niagara	Chautauqua	Orleans	Niagara	Chautauqua
Tomatoes	4.5	2.7	6.5	6.1	4.7	11.3
Beans	0.2	0.2	1.0	0.3	0.3	1.8
Cabbage	1.7	1.5	0.2	2.4	2.6	0.4
Corn for grain	2.9	4.4	3.5	4.0	7.6	6.0
Corn for silage	2.8	3.8	2.5	3.9	6.7	4.4
Sweet corn	1.6	1.4	0.6	2.1	2.5	1.1
Potatoes	1.2	0.9	1.6	1.6	1.6	2.7
Garden	0.1	0.6	0.3	0.1	1.1	0.4
Buckwheat	0.3	0.2	1.2	0.3	0.4	2.1
Oats and barley	....	....	0.3	....	....	0.4
Oats	5.3	6.9	9.4	7.2	12.0	16.2
Barley	2.2	0.2	......	3.0	0.3	....
Peas	2.6	0.5	1.5	3.6	0.8	2.7
Winter wheat	11.8	7.3	0.8	16.2	12.8	1.4
Spring wheat	....	....	0.8	....	....	1.3
Rye	....	....	0.2	....	....	0.3
Hay	22.0	12.3	12.7	30.2	21.4	21.9
Alfalfa	0.3	....	0.1	0.4	....	0.1
Berries	....	....	2.3	....	....	3.9
Grapes	....	0.5	10.0	....	0.9	17.4
Orchard	13.7	14.0	0.9	18.6	24.3	1.6
Nursery stock	....	....	1.5	....	....	2.5
Currants	....	....	0.1	....	....	0.1
Total crops	73.2	57.4	58.0	100.0	100.0	100.0
Total acres in farm	101.4	73.3	80.0	....	....	....

The most important farm enterprise is the production of fruit — particularly apples, peaches, and pears, altho cherries, plums, and grapes also are grown. A few acres of hay, winter wheat, corn for grain or silage, and a variety of truck crops, are raised on each farm (table 40). The most important of the truck crops are tomatoes, cabbage, and sweet corn. The total acreage and crop acres per farm are smaller than on the farms in the Orleans area.

Chautauqua area

The farms included in the Chautauqua area are located in both Chautauqua and Erie Counties, but only a few are in the latter county. The principal tomato-producing section in this area occupies a narrow strip

of land along Lake Erie, commencing about twenty-five miles southwest of Buffalo and extending thru these two counties into Pennsylvania. A number of factories canning tomatoes and making various tomato products are located in this section, and large quantities of tomatoes are shipped out. The H. J. Heinz Company is the largest buyer of tomatoes in the belt, shipping them to its Pittsburg plant.

This region is one of the most important grape-producing sections in the United States. The land slopes back from Lake Erie to some rather steep hills two to six miles from the lake. The air drainage which this topography furnishes, together with the protection furnished by the lake, gives this narrow belt as nearly complete protection against frosts as could be secured in a region located so far north. The topography is level to rolling. The soils are variable. Close to the lake they are principally silt and clay loams, belonging to the Dunkirk series; farther back from the lake there are more gravelly loams of the Dunkirk and Chenango series.

Grapes are the most important crop, with tomatoes second in importance on the farms on which cost figures were obtained. Berries of various kinds also are extensively grown on a small number of farms. Hay, oats, and corn are grown for feed, and a variety of other crops are raised to a limited extent (table 40).

Aside from the climatic advantages which this section has for tomato production, the work on the tomato crop fits in well with that on the other crops grown. Farmers who have a large acreage of grapes and berries require a large amount of help at certain seasons. The work on tomatoes comes at times when the labor is not busy with these other crops.

COST OF PRODUCTION

The average cost of producing an acre of tomatoes in 1920 on the 133 farms on which data were obtained, is given in table 41. The average cost in the different areas is given in table 42.

TABLE 41. AVERAGE COST OF PRODUCING AN ACRE OF TOMATOES ON 133 NEW YORK FARMS GROWING 602.2 ACRES IN 1920

(Average yield per acre, 8.7 tons)

Item	Quantity per acre	Cost per acre	Per cent of total cost
Plants	3,377	$21.98	13.3
Fertilizer	602 lbs.	13.35	8.1
Manure charged to tomatoes	3 tons	6.23	3.8
Labor growing tomatoes:			
Human	62.0 hrs.	26.19	15.9
Horse	61.1 hrs.	14.98	9.1
Use of equipment	61.1 hrs.	5.01	3.0
Use of tractor	0.7 hr.	1.31	0.8
Use of automobile and truck		0.46	0.3
Miscellaneous growing expenses		0.25	0.2
Interest on growing costs		2.03	1.2
Use of land		13.60	8.3
Total growing cost		$105.39	64.0

TABLE 41 (*continued*)

Item	Quantity per acre	Cost per acre	Per cent of total cost
Labor harvesting tomatoes:			
Human	102.7 hrs.	$42.58	25.9
Horse	37.4 hrs.	9.15	5.6
Use of equipment	37.4 hrs.	3.06	1.8
Use of automobile and truck		3.36	2.0
Miscellaneous harvesting expenses		0.59	0.4
Interest on harvesting costs		0.46	0.3
Total harvesting cost		$59.20	36.0
Total cost of crop		$164.59	100.0
Tomatoes disposed of other than to factory	0.08 ton	$ 2.47	
Tomatoes sold to factory	8.64 tons	183.17	
Total receipts from tomatoes	8.72 tons	$185.64	
Price received per ton		$21.29	
Cost per ton growing		$12.09	
Cost per ton harvesting		6.79	
Total cost per ton		$18.88	

The cost of plants, fertilizer, and manure made up about one-fourth of the total cost; the cost of human labor about two-fifths; and the charge for the use of land about one-twelfth. Nearly two-thirds of the cost was incurred previous to harvesting. With a smaller yield the growing cost would represent a larger proportion of the total cost, as the harvesting cost would be lower.

Estimating average costs

The average yield was 8.7 tons per acre. This is higher than the average yield on these farms over a period of years. The most important single factor affecting tomato yields is the weather. The season of 1920 was favorable for tomato production. The cool, dry weather during the early part of the season made strong, healthy plants on which the tomatoes set heavily, while the warm weather during the late summer and early fall was very favorable for ripening the crop. The growing season was long. The first killing frost thruout most of the tomato belt did not come until well into November, which allowed all the tomatoes to ripen.

The farmers were asked to estimate what they considered an average yield of tomatoes on their farms would be if they were given the same care as in 1920. The answers indicated that an average yield on these farms would be about 7.8 tons per acre. This is a somewhat higher yield than would be indicated by the tons of tomatoes received at some of the factories for the past few years. The estimated cost of producing one ton of toma-

TABLE 42. AVERAGE COST OF PRODUCING AN ACRE OF TOMATOES IN 1920 IN DIFFERENT AREAS

Item	On 49 farms in the Orleans area growing 219.4 acres		On 43 farms in the Niagara area growing 115.3 acres		On 41 farms in the Chautauqua area growing 267.5 acres	
	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre
Plants	3,547	$22.04	3,208	$22.49	3,310	$21.67
Fertilizer	487 lbs.	9.58	475 lbs.	12.29	750 lbs.	16.91
Manure charged to tomatoes	3.8 tons	7.86	4.1 tons	8.47	1.9 tons	3.94
Labor growing tomatoes:						
Human	62.3 hrs.	27.48	67.3 hrs.	29.72	59.5 hrs.	23.61
Horse	68.9 hrs.	16.88	72.0 hrs.	17.65	49.9 hrs.	12.28
Use of equipment	68.9 hrs.	5.65	72.0 hrs.	5.91	49.9 hrs.	4.11
Use of tractor	0.3 hr.	0.49	1.0 hr.	1.68	1.0 hr.	1.82
Use of automobile and truck		0.14		0.55		0.69
Miscellaneous growing expenses		0.14		0.53		0.21
Interest on growing costs		1.97		2.27		1.98
Use of land		10.37		10.60		17.55
Total growing cost		$102.60		$112.16		$104.77
Labor harvesting tomatoes:						
Human	96.5 hrs.	$44.11	121.0 hrs.	$53.05	100.0 hrs.	$36.81
Horse	41.8 hrs.	10.25	50.1 hrs.	12.28	28.2 hrs.	6.91
Use of equipment	41.8 hrs.	3.43	50.1 hrs.	4.11	28.2 hrs.	2.31
Use of automobile and truck		3.33		3.08		3.50
Miscellaneous harvesting expenses		......		1.93		0.50
Interest on harvesting costs		0.62		0.70		0.37
Total harvesting cost		$61.74		$75.15		$50.40
Total cost of crop		$164.34		$187.31		$155.17
Tomatoes disposed of other than to factory	0.04 ton	$ 1.25	0.06 ton	$ 1.17	0.10 ton	$ 3.67
Tomatoes sold to factory	9.55 tons	209.14	9.25 tons	204.58	7.65 tons	153.04
Total receipts from tomatoes	9.59 tons	$210.39	9.31 tons	$205.75	7.75 tons	$156.71
Price received per ton		$21.94		$22.10		$20.22
Cost per ton growing		$10.70		$12.05		$13.52
Cost per ton harvesting		6.44		8.07		6.50
Total cost per ton		$17.14		$20.12		$20.02

toes in 1920 if the yield had been 7 tons to the acre, is shown in table 43. This was calculated by the method explained on page 18, where a similar table is given for the pea crop.

TABLE 43. ESTIMATED COST OF PRODUCING ONE TON OF TOMATOES IN 1920 WITH A YIELD OF 7 TONS PER ACRE

(Based on data from 133 farms)

Cost up to harvesting	$105.39 ÷ 7 = $15.06
Cost of harvesting	59.20 ÷ 8.72 = 6.79
Total cost per ton of tomatoes	$21.85

The cost of production varies with changes in the price of the various items of cost. By using the quantities of the various items, the cost with different prices may be estimated. The quantities of the principal

items required to produce one ton of tomatoes in 1920 with a yield of 7 tons per acre, are listed in table 44. The method of calculating these quantities is explained on page 18. With 1920 prices the items included made up about 95 per cent of the total cost.

TABLE 44. ESTIMATED QUANTITIES OF THE PRINCIPAL ITEMS REQUIRED TO PRODUCE ONE TON OF TOMATOES IN 1920 WITH A YIELD OF 7 TONS PER ACRE *
(Based on data from 133 farms)

Item	Quantity
Plants	482
Fertilizer	86 pounds
Manure	0.4 ton
Human labor	20.7 hrs.
Horse labor	13.0 hrs.
Use of equipment	13.0 hrs.
Use of land	0.14 acre

*The items included made up 95 per cent of the total cost in 1920.

Plants

With the exception of human and horse labor, the expense for plants was the largest item of cost. The most usual number of plants set per acre was 3000, but the average number was over 3000 (table 45).

TABLE 45. NUMBER OF TOMATO PLANTS USED PER ACRE, AND AVERAGE COST PER THOUSAND, 133 FARMS, 1920

Area	Plants, first setting	Plants reset	Total plants used	Average cost per thousand
Orleans	3,455	92	3,547	$6.21
Niagara	3,147	61	3,208	7.01
Chautauqua	3,137	173	3,310	6.55
All farms	3,255	122	3,377	$6.51

Because of the climatic conditions in New York State, tomato plants must be raised under glass. They are usually started in hothouses and hardened in coldframes, and transplanted once. Most of the farmers do not grow their own plants because they do not have the necessary equipment. The plants are for the most part grown by plant growers or by the canning companies, who have greenhouses and the other special equipment needed. There are a few farmers who grow enough plants for their own needs. Among the farmers from whom cost figures were obtained, 1 in the Orleans area, 2 in the Niagara area, and 11 in the Chautauqua area, used home-grown plants.

When furnished by or thru the company, the plants are not paid for in cash but are charged to the farmer's account, the cost being deducted from the first payment due the farmer for tomatoes. When the farmer buys plants from a plant grower, there are usually two prices, the cash

price and the fall-payment price. The difference in these two prices is usually 50 cents per thousand. This amount would be interest at the rate of $16\frac{2}{3}$ per cent a year if the cash price were \$6 per thousand and the difference in date of payments were six months. There is, of course, some risk of the grower not being able to collect for the plants in the fall. In calculating costs when growers used their own plants, the plants were charged at the price that would have been paid for plants of a similar quality. No expenses incurred in raising the plants were included in the costs.

Fertilizer

Fertilizer was an important item in the cost of producing tomatoes. The extent to which fertilizer was used in the different areas is shown in table 46. Of the 133 farms, 123 used fertilizer on tomatoes. The heaviest applications were made in the Chautauqua area.

TABLE 46. USE OF FERTILIZER ON TOMATOES IN 1920

Area	Number of farms using fertilizer on tomatoes	Per cent of farms using fertilizer on tomatoes	Number of acres on which fertilizer was used	Per cent of land in tomatoes which was fertilized	Average quantity of fertilizer used per acre fertilized (pounds)
Orleans........	46	94	209.4	95	511
Niagara.......	38	88	101.8	88	538
Chautauqua....	39	95	258.2	97	777
All farms......	123	92	569.4	95	637

The kinds and quantities of fertilizer used are shown in table 47. Acid phosphate, which made up about 25 per cent of the total fertilizer, was used more than any other kind. The balance was mainly a variety of kinds of mixed fertilizers. A considerable number of these were fairly high in nitrogen and potash as well as in phosphorus.

TABLE 47. KINDS AND QUANTITIES OF FERTILIZER USED ON THE 123 FARMS USING FERTILIZER ON TOMATOES IN 1920

Kind of fertilizer *	Number of farms using	Acres of tomatoes on which used	Total pounds applied	Total cost	Per cent of total pounds
1- 8- 1.................	1	3.0	1,067	\$ 20.00	0.3
1- 8- 2.................	11	35.0	17,675	346.17	4.9
1- 8- 3.................	1	2.0	800	15.00	0.2
1- 8- 4.................	3	7.3	2,835	67.29	0.8
1- 9- 3.................	1	4.0	1,600	35.20	0.4
1-10- 0.................	2	4.0	1,230	20.56	0.3
1.5-10-0................	1	4.0	500	10.50	0.1
2- 6- 2.................	1	3.0	750	18.00	0.2

* The numbers used to designate the kinds of fertilizer refer to the percentages of the three constituents, nitrogen, phosphoric acid, and potash, in the fertilizer: for example, a 1-8-2 fertilizer contains 1 per cent of nitrogen (N), 8 per cent of phosphoric acid (P_2O_5), and 2 per cent of potash (K_2O).

TABLE 47 (*continued*)

Kind of fertilizer *	Number of farms using	Acres of tomatoes on which used	Total pounds applied	Total cost	Per cent of total pounds
2– 8– 0	2	4.2	2,000	37.00	0.6
2– 8– 1	2	12.0	6,000	124.50	1.7
2– 8– 2	18	65.9	32,185	735.70	8.9
2– 8– 3	6	21.0	14,283	358.50	3.9
2– 8– 4	8	19.0	7,270	185.81	2.0
2– 8– 5	11	37.2	19,755	543.09	5.5
2– 8–10	8	47.0	35,000	959.00	9.7
2–10– 0	17	68.0	40,735	735.92	11.2
2–10– 4	1	5.0	500	14.00	0.1
2–12– 0	2	6.5	2,537	54.89	0.7
3– 8– 4	2	5.3	2,432	73.92	0.7
3– 8– 5	8	44.0	36,150	944.74	10.0
3– 8–10	1	3.0	2,100	70.35	0.6
3–10– 6	1	5.0	2,500	78.70	0.7
3.5–10–0	1	7.0	7,000	168.00	1.9
4– 8– 3	1	4.0	700	18.90	0.2
4– 8– 4	3	18.5	10,200	302.50	2.8
4– 8– 5	1	6.0	4,000	104.00	1.1
4– 8– 7	1	4.0	6,000	209.25	1.7
5– 8– 2	1	6.0	2,100	55.12	0.6
6– 8– 2	1	2.0	1,000	24.00	0.3
0–10– 8	1	2.0	1,000	28.50	0.3
Acid phosphate	25	147.5	88,350	1,270.13	24.2
Bone meal	4	9.8	5,334	133.85	1.5
Nitrate of soda	7	31.2	3,350	134.80	0.9
Ground fish	1	2.0	2,000	111.00	0.6
Hen manure	1	2.0	1,000	25.00	0.3
Wood ashes	1	2.2	500	7.50	0.1
Total	157†	649.6	362,438	$8,041.39	100.0

* See note on page 48 for numbers used to designate the kind of fertilizer.
† Some of the 123 farms used more than one kind of fertilizer.

Manure

The total amount of manure applied in each of the three areas, and the rate at which it was applied, are shown in table 48. In the Chautauqua area only about half of the land in tomatoes had been manured since 1917, but more fertilizer was used per acre there than in the other areas.

TABLE 48. MANURE APPLIED FROM 1917 TO 1920, TO LAND IN TOMATOES IN 1920

Area	Acres of tomatoes	Acres manured	Tons of manure applied	Tons charged to crop	Tons charged to crop per acre of tomatoes
Orleans	219.4	187.0	2,580	835	3.8
Niagara	115.3	92.5	1,429	470	4.1
Chautauqua	267.5	132.2	1,769	519	1.9
All farms	602.2	411.7	5,778	1,824	3.0

The greater part of the manure was applied directly to the tomato crop or to the preceding crop (table 49). If the charge for manure had been calculated by charging to tomatoes 50 per cent of the manure applied to this land in 1920, 30 per cent of the manure applied in 1919, and 20 per cent of the manure applied in 1918, 3.4 tons per acre instead of 3 tons would have been charged to the crop.

TABLE 49. APPLICATIONS OF MANURE, BY YEARS, TO LAND IN TOMATOES IN 1920

Year manure was applied	Total manure applied		Manure charged to crop	
	Tons	Per cent	Tons	Per cent
1920	2,864	49.6	1,140	62.5
1919	1,487	25.7	450	24.7
1918	915	15.8	183	10.0
1917	512	8.9	51	2.8
Total	5,778	100.0	1,824	100.0

Lime

Lime had been used on the land in tomatoes in 1920 on 4 farms in the Orleans area, 1 in the Niagara area, and 3 in the Chautauqua area, during the years 1916 to 1920. The average yield on these 8 farms was 8.6 tons per acre, while the average yield on all farms was 8.7 tons per acre. The cost of lime charged to the crop is included under miscellaneous expenses in the summary of costs.

Labor

The average rates per hour at which the various classes of labor were charged are given in table 50. The rates for family labor were similar in the different areas, but the rates for hired labor were considerably lower in the Chautauqua area.

TABLE 50. RATES PER HOUR FOR DIFFERENT CLASSES OF LABOR ON TOMATOES, 133 FARMS, 1920

Class of labor	Orleans	Niagara	Chautauqua	All farms
Growing:				
Operators	$0.48	$0.49	$0.47	$0.48
Sons over 16	0.45	0.38	0.46	0.43
Other family	0.31	0.30	0.35	0.32
All family	0.45	0.45	0.46	0.45
Hired men	0.43	0.42	0.36	0.40
Other hired labor	0.43	0.36	0.28	0.33
Total hired labor	0.43	0.41	0.33	0.37
Total growing	$0.44	$0.44	$0.40	$0.42

TABLE 50 (*continued*)

Class of labor	Orleans	Niagara	Chautauqua	All farms
Harvesting:				
Operators	$0.49	$0.50	$0.46	$0.48
Sons over 16	0.44	0.42	0.44	0.43
Other family	0.31	0.34	0.36	0.33
All family	0.44	0.45	0.45	0.45
Hired men	0.47	0.39	0.37	0.41
Other hired labor	0.47	0.44	0.30	0.37
Total hired labor	0.47	0.40	0.32	0.38
Total harvesting	$0.46	$0.44	$0.37	$0.42

The proportion of the work done by these different classes of labor is given in table 51. Nearly 75 per cent of all the work on tomatoes on the farms in the Niagara area was done by family labor. The acreages grown in the Niagara area were so small that extra help was not needed. In the other areas it was necessary to hire more help to grow and harvest the crop. A large proportion of the hired help, particularly at harvest, was women, who are included under "Other hired labor." The lower wage rate paid for this class of labor in the Chautauqua area explains the lower cost of total hired labor there.

TABLE 51. PROPORTION OF WORK ON TOMATOES PERFORMED BY DIFFERENT CLASSES OF LABOR, 133 FARMS, 1920

Class of labor	Per cent of work done			
	Orleans	Niagara	Chautauqua	All farms
Growing:				
Operators	48	56	40	46
Sons over 16	4	11	9	7
Other family	10	8	5	8
All family	62	75	54	61
Hired men	28	21	27	26
Other hired labor	10	4	19	13
Total hired labor	38	25	46	39
Total growing	100	100	100	100
Harvesting:				
Operators	33	47	26	34
Sons over 16	2	8	7	5
Other family	11	15	5	9
All family	46	70	38	48
Hired men	19	22	15	18
Other hired labor	35	8	47	34
Total hired labor	54	30	62	52
Total harvesting	100	100	100	100

Miscellaneous expenses

The items included under miscellaneous expenses, and the amounts at which they were charged, are given in table 52. A few farmers had sown a cover crop in the fall of 1919 on the land in tomatoes in 1920. Seed and other costs on the cover crop were charged to the tomato crop. In one locality a group of farmers cooperated with the factory and the New York State College of Agriculture in employing a specialist to study diseases and other problems affecting the production of canning crops, particularly tomatoes. In the Chautauqua area, in addition to wages, the car fare of extra help was sometimes paid by the farmer. In the Niagara area the growers' association received 1 per cent of the returns from the tomatoes of association members for selling the crop. The companies deducted this from the payments to the farmers and paid it to the association. The returns were figured on the prices before the deduction was made, and the 1 per cent was included as a cost. In the Chautauqua area a large proportion of the tomatoes was sold thru an association, which received 60 cents a ton for this service. This was not included in the price when the returns were calculated, and was therefore not included as a cost. A few growers sold tomatoes before the factories opened. Baskets for these were included as a cost.

TABLE 52. MISCELLANEOUS EXPENSES ON TOMATOES, 133 FARMS, 1920

Item	Orleans	Niagara	Chautauqua	Total
Growing:				
Hauling fertilizer	....	$ 4.00	$ 1.00	$ 5.00
Cover-crop expenses	$15.00	30.50	33.00	78.50
Spray materials	3.00	....	13.00	16.00
Fellowship fees	....	25.00	....	25.00
Car fare of help for setting plants	....	....	5.04	5.04
Lime	13.47	1.62	5.20	20.29
Total growing	$31.47	$61.12	$57.24	$149.83
Harvesting:				
Association fees	....	$220.18	....	$220.18
Baskets for early crop	....	2.25	$121.91	124.16
Car fare of pickers	....	....	10.80	10.80
Total harvesting	....	$222.43	$132.71	$355.14

Interest

As previously explained, interest was charged from the average date when the costs were incurred until returns were received for the tomatoes. The dates at which payment was made varied somewhat. Payment was usually made in two installments. The larger companies paid about one month after the tomatoes were delivered. Ordinarily the smaller companies did not pay as promptly as this. Because of the unsatisfactory condition of the canned-tomato market, some of the smaller companies made only partial payments on the contract dates.

Use of land

The value of the land on which tomatoes were grown, and the average charge per acre for land operated under various tenures, are given in table 53. The highest land values were in the Chautauqua area. This section has climatic and soil conditions which make it particularly adapted to the production of grapes, tomatoes, and other crops that require protection against frost. The acreage of such land is limited. It therefore has a high sale value.

TABLE 53. VALUE PER ACRE AND CHARGES FOR USE OF LAND IN TOMATOES, 133 FARMS, 1920

Area	Value per acre*	Charges per acre			
		Land owned	Land share-rented	Land cash-rented	All farms
Orleans	$130	$11.16	$ 9.54	$ 4.65	$10.37
Niagara	130	11.20	8.96	6.00	10.60
Chautauqua	232	19.18	16.40	11.50	17.55
All farms	$170	$14.92	$10.19	$10.23	$13.60

* Includes only value of land owned or worked on shares.

Most of the tomatoes were grown on land operated by owners (table 54). Because of the amount of labor required by the tomato crop, it is not a very satisfactory crop for a tenant. When grown on shares, the landlord sometimes pays part or all of the cost of the labor of picking.

TABLE 54. PROPORTION OF ACRES OF TOMATOES GROWN UNDER DIFFERENT TENURES, 1920

Tenure	Per cent of acres of tomatoes grown			
	Orleans	Niagara	Chautauqua	All farms
Owned	66	75	76	72
Worked on shares	29	23	4	17
Cash-rented	5	2	20	11
Total	100	100	100	100

RETURNS

The prevailing contract prices for the season of 1920 were $22.50 per ton in the Orleans and Niagara areas and $20 per ton in the Chautauqua area. The tomato crop of 1920 was being harvested just as the business depression was beginning to affect the wholesale price of canned tomatoes.

The prices of canned tomatoes per dozen by months for the years 1919 and 1920 are given in table 55:

TABLE 55. PRICES OF CANNED TOMATOES PER DOZEN, BY MONTHS, IN 1919 AND 1920*

Month	1919	1920
January	$1.80	$1.70
February	1.85	1.70
March	1.50	1.55
April	1 45	1.45
May	1.45	1.65
June	1.70	1.65
July	1.65	1.55
August	1.65	1.55
September	1.90	1.40
October	1.85	1.25
November	1.80	1.10
December	1.75	1.10

*Prices are for No. 3 Standard, f. o. b. Baltimore, as given in the *Almanac of the Canning Industry* (published by the *Canning Trade*, Baltimore) for 1920 and for 1921, page 61.

The 1920 crop of tomatoes was large all over the United States. As a result a considerable part of the crop in certain sections was not harvested. Farmers' estimates of the tons per acre of unharvested tomatoes on the farms studied, were: Orleans, 3.49 tons; Niagara, 1.18 tons; Chautauqua, 2.64 tons. In Niagara County the leading buyer accepted tomatoes up to October 15, the last date at which, according to the contract, deliveries were to be accepted. On farms growing for this company, the estimate of unharvested tomatoes per acre was approximately 1 ton. Even if no attempt had been made to restrict deliveries, some tomatoes would have gone to waste, principally on account of the conflict with the fruit harvest.

Companies may cut down deliveries by being extremely particular as to the quality, by restricting deliveries to a certain number of baskets per day, by accepting tomatoes only on certain days each week, by holding back crates, or by shutting down the plant before the tomatoes are all harvested. When the tomatoes cannot be picked as they ripen, they will soften so that they become too poor in quality to be accepted. Some of the companies had contracts limiting the quantity of tomatoes they would accept to 20 baskets, or about 600 pounds per acre, per day. When the crop was as good as in 1920, this quantity allowed for acceptance of only a part of the ripe tomatoes during the heaviest pickings.

Toward the end of the season some factories cut the price. This may be done in two ways: by paying a lower price per ton, or by deducting a certain percentage from the weight of the tomatoes as they are drawn in. Where the latter method was followed, the total weight of the tomatoes as delivered to the factory was used in this study in all yield figures. The average price received per ton was therefore lower than the contract price.

On the farms studied, very few tomatoes were disposed of other than to the factories (table 56). In the Niagara and Orleans areas the sales

were merely local, while in the Chautauqua area some tomatoes were sold in near-by cities or shipped to more distant markets. The average price received for the market tomatoes sold in the Chautauqua area was 2.6 cents a pound. This was not the net price, as there were expenses for baskets and other marketing costs.

TABLE 56. POUNDS OF TOMATOES SOLD ON 133 FARMS, 1920

Means of disposal	Orleans	Niagara	Chautauqua
Sold to factory	4,189,968	2,117,082	4,093,778
Sold other than to factory	3,360	2,000	33,278

A larger proportion of the tomatoes would probably have been sold as market tomatoes in years when the market for them was better. In 1919, on 326 farms in the Chautauqua area, 3.7 per cent of the tomatoes sold did not go to the canning companies.[4] Market conditions for canned tomatoes were different in 1919 (table 55). The canners then accepted all tomatoes that were offered.

It is evident that the returns from tomatoes grown for manufacture depend in part on market conditions in the fall, even if the tomatoes are contracted for in advance. When tomatoes that are not contracted for are bought in the fall, as is common in some sections, both the price and the quantity that will be bought will vary with the price at which the manufactured products can be sold. The size of the crop and of the resulting pack is, of course, a large factor in the price at which the manufactured products can be sold. If the price paid for contracted tomatoes varied with the price at which the manufactured products could be sold, the restriction of deliveries on the part of the canners and the sales to outside markets by farmers would be less likely to occur. The canner would be protected against losses to which he is exposed when he obligates himself to accept an extremely variable and unknown quantity of tomatoes at a fixed price, to be manufactured into a product the price of which is unknown. When the canner protects himself by selling "futures," he does not incur this risk except on the unsold part of his pack. In years when the production of canned tomatoes is above the average, the risk on the unsold part of a pack must necessarily be considerable. The farmer also would get a higher return for a short crop, as the price per ton under such circumstances would ordinarily be higher than the usual contract price. He would get a smaller return in years when the production was large, but would be assured of a market for his entire crop at some price.

Return per hour of labor

The return per hour of labor spent on the crop is shown in table 57. These figures are for a year when the yield per acre was better than the average. With a yield per acre of 7 tons, the cost per ton on these farms in 1920 would have been about $21.85 and the return per hour of labor

[4] From unpublished data of survey made by the Department of Vegetable Gardening, Cornell University, 1919.

would have been about 39 cents (table 43, page 46). This was 3 cents less than the average cost per hour of labor, and was practically the cost per hour of all hired labor.

TABLE 57. RETURN PER HOUR OF LABOR ON TOMATOES, ON 133 FARMS IN 1920

	Orleans	Niagara	Chautauqua	All farms
Return per hour*	$0.74	$0.54	$0.39	$0.55
Cost per hour	0.45	0.44	0.38	0.42
Profit per hour	$0.29	$0.10	$0.01	$0.13

* The return per hour is calculated by adding to the profit the cost of labor, and dividing by the total hours worked.

Besides the return per hour of labor, there are other factors to be considered in comparing the returns from different enterprises. In the case of the tomato crop, probably the most important of these is competition with other crops for labor. The farmers were asked with what operation the work on the tomato crop conflicted. The most frequent replies were: none, 80; picking peaches, 15; picking apples, 14; sowing wheat, 9; picking pears, 4.

Where large acreages of peaches, early apples, or pears are grown, the tomatoes are competing for labor with crops that ordinarily are profitable. The acreage of tomatoes grown by farmers with a considerable acreage of these kinds of fruit, is usually so small that the conflict is not serious. These fruits are grown most extensively in the Niagara area, where the acreages of tomatoes per farm were small.

Competition for the use of land also must be considered. The rotation in which tomatoes are usually grown is: (1) a cultivated crop; (2) tomatoes; (3) oats; (4) wheat or hay; (5) hay. If tomatoes had not been grown, the crops which the farmers most commonly reported they would have grown were: corn, 25; oats, 8; cabbage, 7; potatoes, 6. Corn and oats ordinarily are not very profitable crops in New York. In 1920, outside of some truck crops such as cucumbers and melons which some of the growers reported they would have grown, probably none of the crops mentioned would have given as large a return per hour of labor as tomatoes.

It is sometimes stated that tomatoes are valuable in the rotation due to their effect on the yield of following crops. Since in New York no crop is so generally grown after tomatoes as is wheat after peas, it was impossible to obtain comparable information as to this effect of tomatoes on the same crop on different farms. The farmers' answers to the question as to what effect they had noticed in the yields of crops following tomatoes were as follows: good, 51; none, 51; bad, 16; no experience, 14. The good effects were generally ascribed to the heavy fertilization given to the tomato crop.

VARIATIONS IN THE COST OF PRODUCING TOMATOES

The variations in the cost of producing tomatoes on the 133 farms are shown in table 58. Between 75 and 80 per cent of the total tonnage

was produced at or below a cost of from $21 to $22 a ton. This tonnage was grown by 61 per cent of the producers on 64 per cent of the acreage.

TABLE 58. RANGE OF COSTS OF PRODUCING TOMATOES ON 133 FARMS IN 1920

Cost per ton	Number of farms	Per cent of total farms	Per cent of farms at this cost or lower	Acres	Per cent of total acres	Per cent of acres at this cost or lower	Tons	Per cent of total tons	Per cent of tons at this cost or lower	Yield per acre (tons)
$10	3	2.3	2.3	17.0	2.8	2.8	319	6.1	6.1	18.8
11	4	3.0	5.3	16.6	2.8	5.6	241	4.6	10.7	14.5
12	1	0.7	6.0	2.5	0.4	6.0	234	0.6	11.3	13.6
13	8	6.0	12.0	40.0	6.6	12.6	415	7.9	19.2	10.4
14	10	7.5	19.5	39.0	6.5	19.1	457	8.7	27.9	11.7
15	9	6.8	26.3	46.8	7.8	26.9	544	10.4	38.3	11.6
16	5	3.8	30.1	17.8	3.0	29.8	241	4.6	42.9	13.5
17	11	8.3	38.3	70.0	11.6	41.5	680	13.0	55.9	9.7
18	12	9.0	47.4	37.8	6.3	47.7	348	6.6	62.5	9.2
19	7	5.3	52.6	48.5	8.1	55.8	394	7.5	70.0	8.1
20	6	4.5	57.1	25.5	4.2	60.0	202	3.8	73.8	7.9
21	5	3.8	60.9	23.5	3.9	63.9	193	3.7	77.5	8.2
22	6	4.5	65.4	25.0	4.2	68.1	174	3.3	80.8	7.0
23	7	5.3	70.7	37.7	6.3	74.3	265	5.1	85.9	7.0
24	6	4.5	75.2	20.5	3.4	77.7	168	3.2	89.1	8.2
25	4	3.0	78.2	14.5	2.4	80.2	97	1.8	90.9	6.7
26	2	1.5	79.7	12.0	2.0	82.1	64	1.2	92.2	5.3
27	2	1.5	81.2	4.0	0.7	82.8	23	0.4	92.6	5.8
28	1	0.7	82.0	2.0	0.3	83.1	13	0.2	92.9	6.5
29	3	2.3	84.2	15.0	2.5	85.6	65	1.2	94.1	4.3
30	2	1.5	85.7	7.0	1.2	86.8	32	0.6	94.7	4.6
31	1	0.7	86.5	3.0	0.5	87.3	14	0.3	95.0	4.7
32	3	2.3	88.7	6.5	1.1	88.4	35	0.7	95.6	5.4
33	1	0.7	89.5	6.0	1.0	89.4	31	0.6	96.2	5.2
34	3	2.3	91.7	7.2	1.2	90.6	41	0.8	97.0	5.7
35	2	1.5	93.2	9.0	1.5	92.1	46	0.9	97.9	5.1
38	1	0.7	94.0	2.3	0.4	92.4	9	0.2	98.1	3.9
40	2	1.5	95.5	23.5	3.9	96.3	55	1.0	99.1	2.3
41	1	0.7	96.2	5.0	0.8	97.2	15	0.3	99.4	3.0
45	1	0.7	97.0	3.0	0.5	97.7	14	0.3	99.7	4.7
47	1	0.7	97.7	2.0	0.3	98.0	5	0.1	99.8	2.5
60+	3	2.3	100.0	12.0	2.0	100.0	13	0.2	100.0	1.1
All farms	133	100.0	......	602.2	100.0	......	5,247	100.0	......	......

LABOR REQUIREMENTS

The time required to perform the various operations on the tomato crop is shown in table 59. The hours given are not the average time for

TABLE 59. AVERAGE HOURS PER ACRE REQUIRED TO PERFORM VARIOUS OPERATIONS ON THE TOMATO CROP ON 133 FARMS GROWING 602.2 ACRES IN 1920

Operation	Number of times operation was performed	Man hours	Horse hours	Tractor hours	Automobile miles	Truck hours
Plowing	......	5.5	11.5	0.3	......	......
Harrowing:						
Spring-tooth	3.9	4.1	9.2	0.2	......	......
Spike-tooth	0.1	0.2	0.4	......	......	......
Disking	0.7	0.9	1.7	0.2	......	......
Rolling	1.5	1.0	2.0	......	......	......
Planking	0.2	0.2	0.4	......	......	......
Cultipacking	0.1	0.1	0.3	......	......	......

TABLE 59 (*continued*)

Operation	Number of times operation was performed	Man hours	Horse hours	Tractor hours	Automobile miles	Truck hours
Putting in cover crop	....	0.1	0.1	......	......	....
Hauling fertilizer	....	0.7	1.2	......	......	....
Applying fertilizer	....	3.0	1.5	......	......	....
Hauling plants	....	2.2	3.7	......	0.2	0.2
Taking care of plants	....	0.8	......	......	......	....
Hauling water	....	0.1	0.1	......	......	....
Marking	....	1.0	1.0	......	......	....
Setting	....	18.3	4.3	......	......	....
Resetting	....	1.5	......	......	......	....
Returning flats	....	0.5	0.9	......	0.1	....
Cultivating:						
Two-horse	2.3	3.4	6.8	......	......	....
One-horse	3.3	10.7	10.7	......	......	....
Hoeing	....	4.3	......	......	......	....
Weeding	....	0.7	......	......	......	....
Supervising	....	0.1	......	......	......	....
Hauling and spreading manure	....	2.5	5.1	......	......	....
Hauling help for setting	....	......	......	......	0.2	....
Summer fallowing	....	0.1	0.2	......	......	....
Total growing	....	62.0	61.1	0.7	0.5	0.2
Harvesting early crop	....	1.5	0.2	......	0.1	0.1
Hauling crates	....	1.6	2.6	......	0.2	0.2
Picking for factory	....	79.9	......	......	......	....
Hauling	....	18.9	33.9	......	......	1.7
Hauling pickers	....	0.3	......	......	2.8	....
Returning empty crates	....	0.3	0.5	......	......	....
Making extra trips	....	0.2	0.2	......	0.2	....
Total harvesting	....	102.7	37.4	......	3.3	2.0
Total labor	....	164.7	98.5	0.7	3.8	2.2

those doing the work, but were obtained by dividing the total number of hours spent on the operation by the total number of acres. The average hours required for performing a particular operation once may be obtained by dividing the average hours as given, by the number of times the operation was performed.

The land is plowed and fitted carefully, spring-tooth, spike-tooth, and disk harrows and rollers being most commonly used according to the nature of the soil. Different methods are used in applying fertilizer. The more common of these are with a grain drill and by hand after the plants are set. A method used by a few growers is to drill the fertilizer in the row with a potato planter, which at the same time makes a furrow in which the plants may be set. The time and the cost of performing this operation by these three methods are shown in table 60. The most economical method is with a grain drill. The use of a potato planter usually saves

marking one way. A few growers who made heavy applications of fertilizer drilled a part and put the remainder in the row with a potato planter.

TABLE 60. HOURS REQUIRED, AND COST OF APPLYING FERTILIZER PER ACRE, BY DIFFERENT METHODS, 1920

Method of application	Number of farms	Average quantity of fertilizer per acre (pounds)	Hours per acre applying fertilizer		Cost per acre of applying fertilizer*
			Man	Horse	
By hand after plants were set	59	497	5.4	......	$2.27
Drilled	38	574	1.4	2.6	1.44
In row with potato planter	7	865	2.5	5.0	2.68

* Labor was charged at the average cost on all farms, 42 cents per hour for man labor, 24.5 cents for horse labor, and 8.2 cents for use of equipment.

The plants are most commonly set in checkrows from 3 to 4 feet apart. Hand-setting is the most usual method, altho on some farms a planter is employed. The relative cost of the two methods is shown in table 61. The time required to mark out also is saved when a machine is used. When the plants are set by hand, the rows are usually furrowed out with a cultivator or a shovel plow.

TABLE 61. HOURS REQUIRED, AND COST OF SETTING BY DIFFERENT METHODS, 133 FARMS, 1920

Method of setting	Number of farms	Acres of tomatoes per farm	Yield per acre (tons)	Hours per acre setting		Cost per acre setting*
				Man	Horse	
By machine	38	4.8	8.4	12.7	7.4	$7.75
By hand	95	4.4	8.8	20.7	3.0	9.67

* Labor was charged at the average cost on all farms, 42 cents per hour for man labor, 24.5 cents for horse labor, and 8.2 cents for use of equipment.

Two-horse cultivators were used to a greater extent than one-horse cultivators. The average time per acre for each cultivation was 1.5 hours when two horses were used and 3.3 hours when one horse was used. At the average labor rates, the cost was about 80 cents per acre less for each cultivation when two horses were used.

The time required to perform the various operations in growing tomatoes is combined into four groups in table 62. The man hours per acre were slightly lower in the Chautauqua area than in the Orleans area, and the horse hours were considerably lower. The greater use of tractors in the Chautauqua area accounts for part of this difference. In the Chautauqua area, tomatoes are grown on land that requires less fitting than

in the other areas, the soils in general being lighter. The difference in the quantity of manure used per acre accounts for the variation in the time required to haul and spread manure. The hours in the Niagara area were the highest of the three sections for each group of operations except plowing and fitting, due to the smaller acreages grown.

TABLE 62. HOURS REQUIRED TO PERFORM VARIOUS GROUPS OF OPERATIONS GROWING TOMATOES IN THE DIFFERENT AREAS IN 1920

Operations	Hours per acre					
	Orleans		Niagara		Chautauqua	
	Man	Horse	Man	Horse	Man	Horse
Plowing and fitting*	12.7	31.7	14.7	28.7	10.7	19.8
Setting, etc	27.6	12.9	29.0	15.7	28.4	11.3
Cultivating, etc	18.9	17.6	19.9	20.6	19.0	16.0
Hauling manure	3.1	6.7	3.7	7.0	1.4	2.8
Total labor for growing	62.3	68.9	67.3	72.0	59.5	49.8

* In addition to the figures given, tractors were used an average of 0.3 hour per acre in the Orleans area and an average of 1 hour per acre in the Niagara and Chautauqua areas.

The crates or baskets for the tomatoes are furnished by the companies. The Heinz Company furnishes a conical-shaped basket holding about five-eighths of a bushel. This is the commonest type of container in the Chautauqua area. The crates generally used in the other areas hold about the same quantity. The time required to pick and haul a ton of tomatoes in the various areas is given in table 63. While the hours per ton were higher in the Chautauqua area than in the Orleans area, the cost per ton was practically the same because of the lower cost of labor per hour.

TABLE 63. AVERAGE LABOR REQUIREMENTS PER TON HARVESTING TOMATOES, ON 133 FARMS IN 1920

	Orleans	Niagara	Chautauqua	All farms
Man hours per ton picking	7.6	10.0	10.4	9.2
Man hours per ton hauling	2.2	2.5	2.0	2.2
Horse hours per ton hauling	3.9	4.6	3.5	3.9
Truck hours per ton hauling	0.2	0.2	0.2	0.2
Man hours per ton for total harvesting	10.1	13.0	12.9	11.8
Horse hours per ton for total harvesting	4.4	5.4	3.6	4.3
Truck hours per ton for total harvesting	0.2	0.2	0.3	0.2
Cost of harvesting per ton	$6.44	$8.07	$6.51	$6.79
Miles to receiving station	3.4	3.1	2.3	2.9

Estimates of the time lost in waiting at the receiving point to unload tomatoes were obtained. The average length of time lost per acre was estimated to have been 4.2 hours in the Orleans area, 3.2 hours in the

Niagara area, and 4 hours in the Chautauqua area. This time was included in the length of time spent in hauling. The tonnage of tomatoes which the canning companies were required to handle was above normal and a certain amount of delay was unavoidable. In the Niagara area, where the tomatoes for the most part were delivered at loading stations to be shipped to Rochester, a number of extra trips had to be made to get crates. The hours per acre hauling crates in the Niagara area and the adjoining area, Orleans, with substantially the same yield, were as follows:

	Man hours	Horse hours	Truck hours
Niagara	4.0	6.2	0.8
Orleans	1.7	3.2	.....

At the rates at which it was charged, the extra labor spent in the Niagara area amounted to over $3 an acre.

FACTORS AFFECTING THE COST OF PRODUCTION OF TOMATOES

Yield per acre

The yield per acre is probably the most important single factor affecting the cost per ton in the production of tomatoes. The relation between the yield per acre and the profits is shown in table 64. The costs in detail for each yield group are given in table 65.

TABLE 64. Relation between Yield of Tomatoes per Acre, and Returns above the Cost of Harvesting, 133 Farms, 1920*

Yield per acre (tons)	Number of farms	Average yield per acre (tons)	Average growing cost per acre	Increase in growing cost per acre over lowest-yielding group	Return per acre above cost of harvesting	Increase in return per acre above cost of harvesting, over group with lowest yield per acre†
Less than 8	55	5.5	$101	....	$ 73	....
8–11	47	9.4	104	$ 3	138	$ 65
Over 11	31	14.3	116	15	219	146

*The correlation coefficient between the yield per acre and the cost per ton was − 0.335 ± 0.052.
† A small part of this increase was due to the fact that more of the farms in the higher-yielding groups were located in the Orleans and Niagara areas, where a higher price was paid per ton.

The growing cost per acre increased only $3 between the farms that had yields of less than 8 tons per acre and those that had yields of from 8 to 11 tons per acre. However, there was an increase in the average yield per acre of 3.9 tons, and of $65 in the return per acre above the cost of harvesting, between those two groups of farms. The increase in the growing cost per acre was only $15 between the lowest- and the highest-yielding group, while the increase in the return above the cost of harvesting amounted to $146 per acre.

TABLE 65. AVERAGE COST OF PRODUCING AN ACRE OF TOMATOES ON FARMS WITH DIFFERENT YIELDS PER ACRE, 1920

Item	Yield less than 8 tons per acre, 55 farms, 256.8 acres, averaging 5.5 tons per acre		Yield 8 to 11 tons per acre, 47 farms, 224.5 acres, averaging 9.4 tons per acre		Yield over 11 tons per acre, 31 farms, 120.9 acres, averaging 14.3 tons per acre	
	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre
Plants	3,501	$21.69	3,209	$21.56	3,425	$23.34
Fertilizer	570 lbs.	12.30	639 lbs.	14.30	600 lbs.	13.83
Manure charged to tomatoes	2 tons	4.30	3.1 tons	6.22	4.9 tons	10.36
Labor growing tomatoes:						
Human	63.2 hrs.	25.82	58.0 hrs.	24.41	67.0 hrs.	29.92
Horse	58.2 hrs.	14.26	60.4 hrs.	14.86	68.3 hrs.	16.73
Use of equipment	58.2 hrs.	4.77	60.4 hrs.	4.97	68.3 hrs.	5.60
Use of tractor	1.0 hr.	1.66	0.6 hr.	1.00	0.6 hr.	1.13
Use of automobile and truck	....	0.61	....	0.22	....	0.59
Miscellaneous growing expenses	....	0.29	....	0.30	....	0.04
Interest on growing costs	....	1.91	....	2.03	....	2.30
Use of land	....	13.73	....	14.46	....	11.74
Total growing cost	....	$101.34	....	$104.33	....	$115.58
Labor harvesting tomatoes:						
Human	74.9 hrs.	$30.31	107.6 hrs.	$43.98	152.7 hrs.	$66.11
Horse	25.8 hrs.	6.33	38.9 hrs.	9.54	58.9 hrs.	14.43
Use of equipment	25.8 hrs.	2.12	38.9 hrs.	3.19	58.9 hrs.	4.83
Use of automobile and truck	....	2.63	....	3.76	....	4.17
Miscellaneous harvesting expenses	....	0.49	....	0.59	....	0.81
Interest on harvesting costs	....	0.37	....	0.53	....	0.85
Total harvesting cost	....	$42.25	....	$61.59	....	$91.20
Total cost of crop	....	$143.59	....	$165.92	....	$206.78
Tomatoes disposed of other than to factory	0.10 ton	$ 2.98	0.06 ton	$ 2.03	0.08 ton	$ 2.18
Tomatoes sold to factory	5.38 tons	111.83	9.38 tons	197.54	14.18 tons	308.09
Total receipts from tomatoes *	5.48 tons	$114.81	9.44 tons	$199.57	14.26 tons	$310.27
Price received per ton	....	$20.95	....	$21.14	....	$21.76
Cost per ton growing	....	$18.49	....	$11.06	....	$ 8.10
Cost per ton harvesting	....	7.71	....	6.52	....	6.40
Total cost per ton	....	$26.20	....	$17.58	....	$14.50
Return per hour of human labor	....	$0.20	....	$0.62	....	$0.91

* The estimated tonnage per acre not harvested for the three groups was as follows: with yield less than 8 tons, 3.2 tons; with yield from 8 to 11 tons, 2.2 tons; with yield over 11 tons, 2.5 tons.

The average land cost per acre was lower in the highest-yielding group than in the other two groups. A large proportion of the farms in this group were located in the Orleans and Niagara areas (table 66), where the land had a lower value per acre than in the Chautauqua area. Land values are based, not on superiority for producing tomatoes alone, but on advantages for producing a variety of crops. The advantage of a particular location for tomatoes will vary from year to year. When the delivery of the crop was cut down in 1920, the growers on the lighter

sandy and gravelly soils had a larger proportion of their tomatoes harvested than did the growers on the silt and clay loam soils. An early frost would operate in the same way. Also, a dry year would give the greater advantage to the heavy soils, and a wet year to the lighter soils. The value of land does not represent the advantage that a particular kind of land may have in any one year.

TABLE 66. FARMS IN EACH AREA WITH DIFFERENT YIELDS OF TOMATOES, 1920

Yield per acre (tons)	Orleans	Niagara	Chautauqua	All farms
Less than 8	19	13	23	55
8–11	15	17	15	47
Over 11	15	13	3	31
All farms	49	43	41	133

The proportion of tomatoes produced on farms with different yields per acre is given in table 67. Forty-two per cent of the farms having yields of less than 8 tons of tomatoes per acre produced only 27 per cent of the total tonnage of tomatoes.

TABLE 67. PROPORTION OF TOMATOES PRODUCED ON FARMS WITH DIFFERENT YIELDS PER ACRE, 133 FARMS, 1920

Yield per acre (tons)	Number of farms	Per cent of total farms	Number of acres	Per cent of total acres	Number of tons	Per cent of total tons
Less than 8	55	42	256.8	43	1,406	27
8–11	47	35	224.5	37	2,118	40
Over 11	31	23	120.9	20	1,723	33
All farms	133	100	602.2	100	5,247	100

Some factors have considerable influence on the yield per acre but do not increase the cost of production. Some of these are, setting plants and cultivating at just the right time and in the proper manner, and favorable weather conditions. Certain other practices increase yields but also increase costs. Whether or not these are profitable depends on whether the value of the increased yield is greater than the cost of the practice.

Acres of tomatoes per farm

Most of the growers raise small acreages of tomatoes (table 68). In the Niagara area, none of the farmers interviewed grew more than 5 acres. In the Chautauqua area there were a considerable number of growers who had fairly large acreages.

While the farmers growing small acreages are more numerous, a comparatively few who grow larger acreages raise a considerable proportion

kept accounts. This is due to a number of causes: larger acreages were grown; a larger number of the farms were located in the Orleans and Chautauqua areas, where the hours per acre were, on the average, lower; tractors and other labor-saving machines were used to a greater extent; the farms were a selected group of farms, on which the general efficiency might be expected to be better.

TABLE 73. AVERAGE COST OF PRODUCING AN ACRE OF TOMATOES IN 1920 ON FARMS ON WHICH ACCOUNTS WERE KEPT ON THE CROP, AND ON FARMS ON WHICH COST FIGURES WERE OBTAINED BY THE SURVEY METHOD

Item	Accounts — 26 farms, 131.8 acres, averaging 10.3 tons per acre		Records — 107 farms, 470.4 acres, averaging 8.3 tons per acre	
	Quantity per acre	Cost per acre	Quantity per acre	Cost per acre
Plants	3,435	$23.38	3,361	$21.55
Fertilizer	664 lbs.	15.01	584 lbs.	12.89
Manure charged to tomatoes	3.6 tons	8.07	2.9 tons	5.72
Labor growing tomatoes:				
Human	51.8 hrs.	21.57	64.9 hrs.	27.38
Horse	53.2 hrs.	13.03	63.3 hrs.	15.53
Use of equipment	53.2 hrs.	4.36	63.3 hrs.	5.20
Use of tractor	1.0 hr.	1.75	0.7 hr.	1.18
Use of automobile and truck		0.55		0.44
Miscellaneous growing expenses		0.29		0.24
Interest on growing costs		1.95		2.06
Use of land		13.15		13.73
Total growing cost		$103.11		$105.92
Labor harvesting tomatoes:				
Human	112.8 hrs.	$44.61	100.0 hrs.	$42.02
Horse	34.5 hrs.	8.45	38.2 hrs.	9.35
Use of equipment	34.5 hrs.	2.83	38.2 hrs.	3.13
Use of automobile and truck		5.67		2.71
Miscellaneous harvesting expenses		0.65		0.58
Interest on harvesting costs		0.58		0.51
Total harvesting cost		$62.79		$58.30
Total cost of crop		$165.90		$164.22
Tomatoes disposed of other than to factory	0.08 ton	$ 2.67	0.08 ton	$ 2.41
Tomatoes sold to factory	10.26 tons	218.64	8.18 tons	173.24
Total receipts from tomatoes	10.34 tons	$221.31	8.26 tons	$175.65
Price received per ton		$21.40		$21.27
Cost per ton growing		$9.97		$12.82
Cost per ton harvesting		6.07		7.06
Total cost per ton		$16.04		$19.88

COST OF PRODUCING TOMATOES IN OTHER STATES IN 1920

New Jersey

The New Jersey Agricultural Experiment Station has obtained information on the cost of producing tomatoes in southern New Jersey for the years 1918, 1919, and 1920. The average costs of growing tomatoes in 1920 in that section are given in table 74.[5] The yield per acre was lower and the cost per ton was higher than in New York. The expense

TABLE 74. Cost per Acre of Producing Canning Tomatoes on 205 Farms in New Jersey Growing 2040.25 Acres of Tomatoes in 1920

Item	Quantity per acre	Cost per acre
Cost of hotbed material		$ 0.16
Seed		0.61
Plants	1,338*	3.26
Cover-crop seed	28.2 lbs.	1.04
Fertilizer†	859 lbs.	18.71
Manure†	7.74 tons	16.28
Lime†	0.24 ton	0.66
Spray materials		0.81
Labor growing tomatoes:		
Human	57.4 hrs.	21.94
Horse	52.4 hrs.	10.61
Use of equipment	52.4 hrs.	3.67
Use of tractor	0.6 hr.	0.92
Use of automobile and truck		0.45
Insurance		0.14
Interest		2.00
Use of land		11.30
Total growing cost		$92.56
Labor harvesting tomatoes:		
Human	71.0 hrs.	$27.16
Horse	28.3 hrs.	5.72
Use of equipment	28.3 hrs.	1.98
Use of truck	3.4 hrs.	5.04
Hauling		0.03
Baskets	23.4	3.13
Total harvesting cost		$43.06
Total cost of crop		$135.62
Yield per acre sold	5.74 tons	
Yield per acre including unharvested tomatoes	6.07 tons	
Cost per ton growing tomatoes sold		$16.13
Cost per ton harvesting tomatoes sold		7.50
Total cost per ton of tomatoes sold		$23.63

* This is the number of plants purchased. Plants that were raised are not included.
† Quantity figures are for total applied. Cost figures are for proportion charged, which was influenced by rotation.

[5] New Jersey Agr. Exp. Sta., Bul. 353:52-53. 1921.

for seed and plants was considerably lower in New Jersey, because there tomato plants are grown in the field. The cost of both fertilizer and manure was higher in New Jersey than in New York. The combined expenses for plants, fertilizer, and manure in the two States were about equal. The man and horse hours per acre were lower in New Jersey. Larger acreages were grown per farm. The hours were a little higher than for New York farms growing over 7 acres (table 70).

Ohio

Cost figures on tomatoes were obtained in 1920 on 27 farms in Wood County, Ohio, by the Ohio State College of Agriculture. The accounting method was used. The average cost per acre on 26 of these farms is given in table 75:[6]

TABLE 75. AVERAGE COST OF PRODUCING AN ACRE OF TOMATOES ON 26 OHIO FARMS GROWING 185.7 ACRES IN 1920

Item	Quantity per acre	Cost per acre
Plants	2,248	$ 8.99
Fertilizer		2.40
Manure charged to crop	2.3 tons	7.90
Labor growing tomatoes:		
Human	34 hrs	15.96
Horse	34 hrs	7.33
Use of equipment	34 hrs	2.38
Use of tractor		3.07
Interest and taxes on land		17.68
Interest on growing expenses		1.58
Total growing cost		$67.29
Total harvesting cost		$33.46
Total cost of crop		$100.75
Yield per acre delivered	6.4 tons	
Yield per acre including unharvested tomatoes	8.1 tons	
Cost per ton growing tomatoes delivered		$10.51
Cost per ton harvesting tomatoes delivered		5.23
Total cost per ton of tomatoes delivered		$15.74

An average of 7.1 acres of tomatoes per farm was grown on the Ohio farms. The average yield harvested per acre was lower than on the New York farms, and about the same proportion of the crop was not harvested. Very little fertilizer was used. The manure was charged at from $3 to $4 per ton.

The hours of human and horse labor were less than in New York. The costs given were for farmers keeping accounts on the crop, therefore they might be expected to be lower than for average farms. Also, the acreage of tomatoes per farm was fairly large. Tractors were used on

[6] Adapted from a mimeographed report by R. F. Taber.

42 per cent and machine setters on 81 per cent of the farms. Fewer plants and less fertilizer and manure were used per acre than in New York. Less time was required to haul these materials, to set the plants, to apply the fertilizer, and to spread the manure. The majority of the farmers used two-horse cultivators and cultivated only three or four times. More of the growers in New York used one-horse cultivators and cultivated five or six times. The land in this part of Ohio can be prepared for planting in less time than is required on New York farms, because the soil is more easily worked. Natural advantages, such as a more easily worked soil or land capable of producing high yields per acre without heavy applications of fertilizer, are likely to be offset, in part at least, by higher land value.

SWEET CORN

The most important States in the production of sweet corn for canning are the Middle-Western States of Iowa and Illinois. However, a considerable quantity of corn is packed in the Eastern States, particularly in Maryland, Maine, and New York. The high quality of corn grown in a cool climate explains the importance of corn canning in States that are not ordinarily considered as important corn-producing States. The location of the factories canning corn in New York State in 1920 is shown in figure 5. Data on the cost of producing sweet corn were obtained in

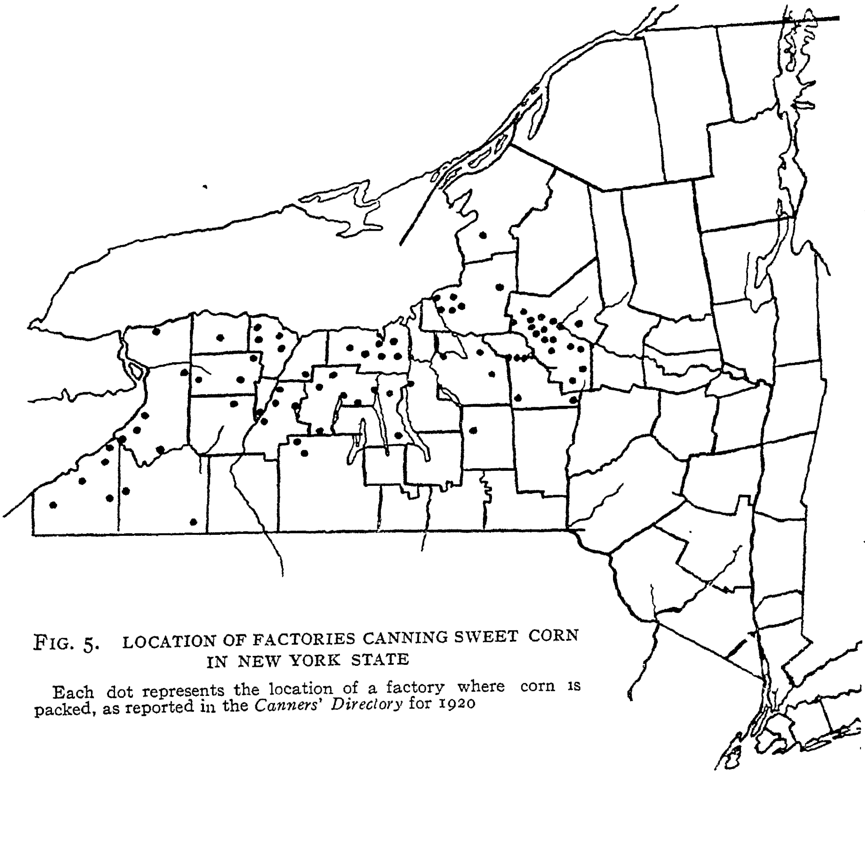

FIG. 5. LOCATION OF FACTORIES CANNING SWEET CORN IN NEW YORK STATE

Each dot represents the location of a factory where corn is packed, as reported in the *Canners' Directory* for 1920

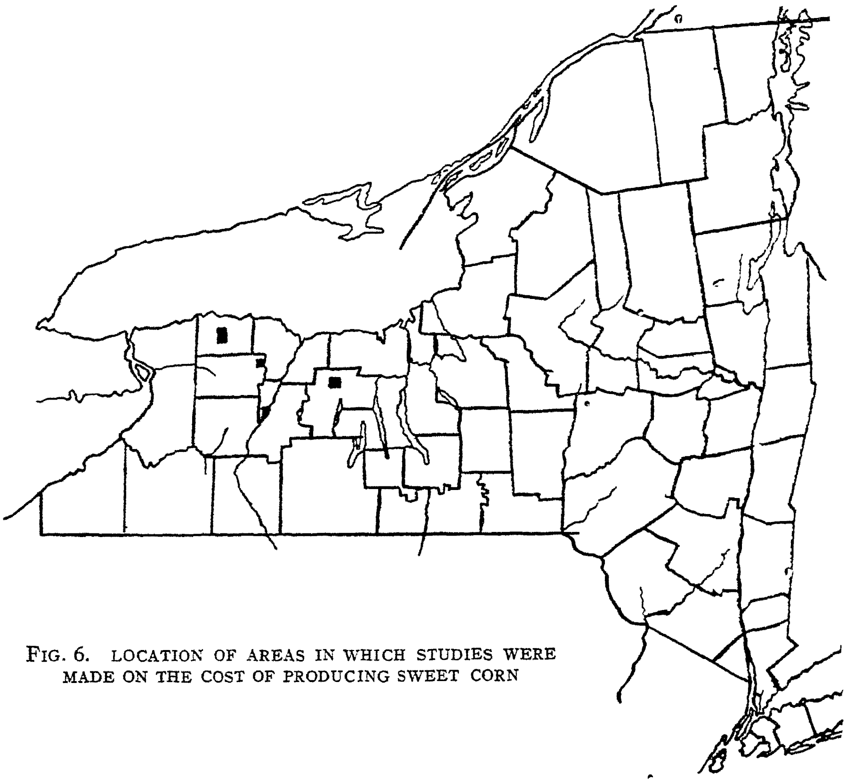

FIG. 6. LOCATION OF AREAS IN WHICH STUDIES WERE MADE ON THE COST OF PRODUCING SWEET CORN

three areas — Orleans, Ontario, and Livingston. Accounts were kept on nine farms in Orleans and Genesee Counties; this area is designated as the Orleans area. Cost figures were obtained on twelve farms in northwestern Ontario County. Records were obtained by the survey method on thirteen farms located on the Genesee River flats between Geneseo and Mount Morris in Livingston County. The location of these areas is shown in figure 6.

AGRICULTURAL CONDITIONS IN THE AREAS STUDIED

The agricultural conditions in these three sections differ somewhat. The most important crops grown on the farms in the Orleans area were apples, winter wheat, hay, and various crops for canning factories. The most important crops grown in the Ontario area were winter wheat, hay, alfalfa, apples, potatoes, and peas and sweet corn for the canning factory. The topography is rolling, and the soils are principally loams and sandy loams well drained and well supplied with lime. In the Livingston area the most important crops were peas and sweet corn for the canning factory, winter wheat, hay, and beans. This area is located on the level land along the Genesee River. The soil is a silt loam, very deep and productive. Most of this land is subject to over-flow nearly every year. In July of 1920 a considerable proportion of the land in sweet corn in this area was flooded.

TABLE 76. AVERAGE COST OF PRODUCING AN ACRE OF SWEET CORN IN 1920 IN DIFFERENT AREAS

Item	On 9 farms in the Orleans area growing 59.3 acres			On 12 farms in the Ontario area growing 87.2 acres			On 13 farms in the Livingston area growing 388 acres		
	Quantity per acre	Cost per acre	Per cent of total cost	Quantity per acre	Cost per acre	Per cent of total cost	Quantity per acre	Cost per acre	Per cent of total cost
Seed	0.23 bu.	$ 1.64	2.9	0.34 bu.	$ 2.02	3.0	0.32 bu.	$ 1.93	3.5
Fertilizer	146 lbs.	2.28	4.0	136 lbs.	2.04	3.1	2 lbs.	0.04	0.1
Manure charged to sweet corn	2.0 tons	4.01	7.0	2.7 tons	5.41	8.1	0.9 ton	1.84	3.4
Labor growing sweet corn:									
Human	25.9 hrs.	11.64	20.2	29.2 hrs.	12.22	18.4	44.1 hrs.	14.72	26.8
Horse	44.0 hrs.	10.77	18.8	47.3 hrs.	11.57	17.3	37.7 hrs.	9.24	16.8
Use of equipment	44.0 hrs.	3.61	6.3	47.3 hrs.	3.87	5.8	37.7 hrs.	3.09	5.6
Use of tractor	1.3 hrs.	2.24	3.9	2.1 hrs.	3.66	5.5	0.9 hr.	1.52	2.8
Use of automobile and truck	......	0.12	0.2	......	......	......	......	0.01	......
Interest on growing costs	......	1.01	1.8	......	0.95	1.4	......	0.76	1.4
Use of land	......	9.50	16.6	......	8.76	13.1	......	10.16	18.5
Total growing cost	......	$46.82	81.7	......	$50.50	75.7	......	$43.31	78.9
Labor harvesting sweet corn:*									
Human	13.6 hrs.	$6.61	11.5	22.7 hrs.	$9.42	14.3	20.8 hrs.	$7.22	13.2
Horse	10.9 hrs.	2.66	4.6	15.9 hrs.	3.90	5.8	13.0 hrs.	3.20	5.8
Use of equipment	10.9 hrs.	0.89	1.6	15.9 hrs.	1.30	1.9	13.0 hrs.	1.07	2.0
Use of automobile and truck	......	0.18	0.3	......	1.49	2.2	......	......	......
Miscellaneous harvesting expenses	......	0.10	0.2	......	......	......	......	......	......
Interest on harvesting costs	......	0.08	0.1	......	0.08	0.1	......	0.06	0.1
Total harvesting costs *	......	$10.52	18.3	......	$16.19	24.3	......	$11.55	21.1
Total cost of crop	......	$57.34	100.0	......	$66.69	100.0	......	$54.86	100.0
Value of miscellaneous receipts with harvesting costs deducted *	......	11.70	20.4	......	11.43	17.1	......	9.37	17.1
Net cost of sweet corn	......	$45.64	79.6	......	$55.26	82.9	......	$45.49	82.9
Value of sweet corn†	1.7 tons	$42.93	......	3.4 tons	$79.11	......	2.7 tons	$54.20	......
Price received per ton†	......	$25 00	......	......	$23.27	......	......	$20.07	......
Net cost per ton†	......	$26.85	......	......	$16.25	......	......	$16.85	......

* Labor and all other costs for harvesting stalks are deducted from costs and from the estimated value of miscellaneous receipts in this table.
† Quantity given is for husked corn in the Orleans area and for unhusked corn in the Ontario and Livingston areas.

Two products, corn and stalks, are produced by the sweet-corn crop. The economical production of sweet corn requires that the stalks be used by some form of livestock. The Orleans and Ontario areas are not dairy sections. In the Livingston area dairying is more important, an average of twenty dairy cattle per farm being kept. A considerable number of sheep were kept in the Orleans and Ontario areas.

The common rotation in which sweet corn is grown on the upland soils in these areas is: (1) corn or some other cultivated crop for one or two years; (2) oats, barley, or peas; (3) wheat; (4) hay for one or two years. On the valley soils sweet corn is often grown on the same field for a number of years in succession. When the land is to be seeded down again, the succession of crops would be as indicated for the upland soils.

COST OF PRODUCTION

The average cost of producing one acre of sweet corn in 1920 on the farms visited in these three areas, is given in table 76.

Seed, fertilizer, and manure

Seed was a minor item in the cost of producing sweet corn. It was in all cases furnished by the factory. The usual rate of seeding was a peck to the acre. Fertilizer also was a minor item of cost. Acid phosphate was the fertilizer most generally used. The common rate of application was from 200 to 250 pounds per acre. Manure was a larger item of cost than fertilizer. Neither fertilizer nor manure was used extensively in the Livingston area on the land in sweet corn. This land is naturally very fertile. In all the areas, most of the manure charged to the sweet corn was applied directly to the 1920 crop.

Labor

The largest item of cost was labor. The rates at which the various classes of labor were charged in the different regions are given in table 77. The highest rates, both for hired and for family labor, were in the Orleans area. The high wages paid for help in this section during the season of 1920 are indicated by the rate of 50 cents per hour paid for "other hired labor" during harvesting. This wage was paid to women for picking

TABLE 77. RATES PER HOUR FOR DIFFERENT CLASSES OF LABOR ON SWEET CORN IN 1920

Class of labor	Orleans	Ontario	Livingston
Growing:			
Operators	$0.48	$0.48	$0.45
Sons over 16	0.50	0.40	0.40
Other family	0.30	....	0.30
All family	0.48	0.47	0.43
Hired men	0.43	0.39	0.37
Other hired labor	0.40	....	0.25
Total hired labor	0.42	0.39	0.31
Total growing	$0.45	$0.42	$0.33

TABLE 77 (*continued*)

Class of labor	Orleans	Ontario	Livingston
Harvesting:			
Operators	$0.48	$0.48	$0.44
Sons over 16	0.50	0.40	0.40
Other family	....	0.19	0.30
All family	0.48	0.44	0.43
Hired men	0.48	0.40	0.36
Other hired labor	0.50	....	0.24
Total hired labor	0.49	0.40	0.32
Total harvesting	$0.48	$0.42	$0.35

sweet corn. On the farms on which they were employed, a considerable acreage of sweet corn was not picked because it appeared more profitable to use the available help to harvest tomatoes and apples.

The proportion of the work performed by the different classes of labor is given in table 78. In the Orleans area a larger proportion of the growing work was done by family labor than in the other areas, due to the smaller farms and the fewer acres of crops grown per farm. A larger proportion of the harvesting labor was hired in the Orleans area. Since this was for the most part hand work and came at a very busy season, extra help was necessary. The help included under "Other hired labor" was

TABLE 78. PROPORTION OF WORK ON SWEET CORN PERFORMED BY DIFFERENT CLASSES OF LABOR, 1920

Class of labor	Per cent of work done		
	Orleans	Ontario	Livingston
Growing:			
Operators	45	30	13
Sons over 16	4	3	5
Other family	1	....	2
All family	50	33	20
Hired men	33	67	40
Other hired labor	17	....	40
Total hired labor	50	67	80
Total growing	100	100	100
Harvesting:			
Operators	33	27	20
Sons over 16	4	3	7
Other family	....	4	1
All family	37	34	28
Hired men	41	66	46
Other hired labor	22	....	26
Total hired labor	63	66	72
Total harvesting	100	100	100

the extra labor used to hoe and pick the corn. This class of help was used extensively on the farms in the Livingston area, where large acreages were grown.

Miscellaneous expenses

In the summary of costs, the expenses of harvesting fodder are omitted and credit is given for the estimated value of stalks less the cost of harvesting. The expenses for twine and for silo filling were therefore not included. The only item left under this heading was the fee collected by the grower's association on the farms in Genesee County included in the Orleans area.

Use of land

In the Livingston area over 80 per cent of the corn was grown on cash-rented land. The most usual rent paid was $10 per acre in addition to the taxes. The average charge per acre for the use of land was slightly higher in this area than in the Orleans and Ontario areas.

RETURNS

There are two sources of returns from sweet corn — the corn and the stalks. The principal return, however, is from the corn. There are two bases on which sweet corn is bought in New York State, the unhusked and the husked. When bought on the unhusked basis, the weight of the unhusked corn as drawn from the field is paid for. When bought on the husked basis, the loads as drawn in are weighed. A sample is taken from each load and husked. The percentage that the husked corn from this sample represents of the unhusked corn, is calculated. This percentage is applied to the whole load and the farmer is paid for the calculated weight of husked corn. This method is sometimes called *averaging*.

In the Orleans area the corn was bought on the husked basis. The growers from whom figures were obtained hauled into the factory 263,274 pounds of unhusked corn. They were paid for 199,382 pounds of husked corn. The percentage of husked corn, commonly known as the *test*, was 75.7. This corn was all of the Evergreen variety.

The low yield in the Orleans area was due to the complete failure of corn on two farms, and the fact that a large acreage on another farm was not harvested because of the pressure of other farm work. The average yield of unhusked corn on the harvested acreage was 3.35 tons per acre.

The price paid for corn of the Evergreen variety in the Orleans area was $25 per ton of husked corn, which, with a test of 75.7 per cent, was equivalent to a price of $18.92 for unhusked corn. In the Ontario area the prices paid per ton of unhusked corn for the different varieties were as follows: Evergreen and Hickox, $20; Golden Bantam, $32.50. The average yields per acre of these three varieties in this area in 1920 were: Evergreen, 7646 pounds; Hickox, 7240 pounds; Golden Bantam, 5326 pounds. With these yields and prices, the returns for corn alone from the Golden Bantam were more than the returns from the other two varieties. However, the fodder from the Golden Bantam is usually considered to be worth less per acre.

The average yield per acre and price per ton would vary with the proportion of the different varieties in the total acreage. The acreages of the different varieties grown are given in table 79:

TABLE 79. ACRES OF DIFFERENT VARIETIES OF SWEET CORN GROWN IN 1920

Variety	Orleans	Ontario	Livingston	Total
Evergreen	59.3	30.0	92.0	181.3
Early Crosby	....	....	110.0	110.0
Country Gentleman	....	....	47.0	47.0
Hickox	....	28.0	20.0	48.0
Howling Mob	....	....	31.0	31.0
Golden Bantam	....	29.2	15.0	44.2
Early Orange	....	....	45.0	45.0
Charlevoix	....	....	28.0	28.0
Total	59.3	87.2	388.0	534.5

Miscellaneous returns

The stalks may be used in various ways. Stock may be turned in and the stalks not cut, or the stalks may be cut and fed as dry fodder, or they may be put into silos. At the factories the husks and the cobs are stacked or put into silos. The growers usually have the privilege of buying the resulting ensilage at a cost of $2 or $3 per ton. Where the growers had this privilege, the estimated value of this material above the price paid and the cost of hauling was credited to the crop. The miscellaneous returns represent, therefore, the estimated value of the standing stalks plus the value above cost of the silage obtained from the factory (table 80). The value of stalks was less in the Livingston area because most of the stalks were not harvested until they had been badly frosted.

TABLE 80. MISCELLANEOUS RETURNS PER ACRE OF SWEET CORN IN 1920

Source of return	Orleans	Ontario	Livingston
Value of standing stalks	$10.40	$9.65	$6.13
Value of ensilage from factories, above cost to grower	1.30	1.78	3.24
Total	$11.70	$11.43	$9.37

LABOR REQUIREMENTS

The time spent on the various operations on the sweet-corn crop is given in table 81. The land is fitted for sweet corn in much the same manner as for any other cultivated crop. The greater part of the corn in the areas visited was planted with a two-horse corn planter. On several farms, particularly in the Ontario area, the corn was gone over with a weeder before it was cultivated. The average number of cultivations with a two-horse cultivator were: Orleans, 3; Ontario, 4.2; Livingston, 4. In addition to this, some cultivation was done with a one-horse cultivator, the average number of cultivations being: Orleans, 0.2; Ontario, 1.0; Livingston, 0.5. In the Livingston area the corn was practically all

TABLE 81. AVERAGE HOURS PER ACRE REQUIRED TO PERFORM VARIOUS OPERATIONS ON THE SWEET-CORN CROP IN 1920

Operation	21 farms in the Orleans and Ontario areas				13 farms in the Livingston area			
	Number of times operation was performed	Man hours	Horse hours	Tractor hours	Number of times operation was performed	Man hours	Horse hours	Tractor hours
Plowing	....	5.4	13.3	0.6	....	4.3	10.6	0.4
Harrowing	3.2	2.5	6.2	0.6	3.0	2.3	5.8	0.3
Disking	0.8	0.8	0.6	0.6	0.2	0.3	0.6	0.1
Rolling	1.0	0.7	1.4	......	2.0	1.6	3.2	....
Cultipacking	0.1	0.1	0.4	......	0.1	0.1	0.3	....
Hauling seed and fertilizer	....	0.1	0.2	......	....	0.1	0.1	....
Marking	0.3	0.4	0.4	......	....	......	......	....
Planting	1.0	1.5	1.5	......	1.0	0.9	1.8	....
Replanting	....	0.2	0.1	......	....	0.5	0.8	0.1
Weeding	0.7	0.7	1.3	......	....	......	......	....
Cultivating:								
Two-horse	3.8	7.7	15.4	......	3.9	5.8	11.6	....
One-horse	0.5	1.2	1.2	......	0.5	1.0	1.0	....
Hoeing	....	4.4	......	......	....	25.4	......	....
Transporting extra help for hoeing	....	......	......	......	....	0.1	0.2	....
Supervising	....	......	......	......	....	1.0	......	....
Hauling and spreading manure	....	2.1	3.9	......	....	0.7	1.7	....
Total	....	27.8	45.9	1.8	....	44.1	37.7	0.9
Acres of sweet corn per farm	7.0				29.8			

hoed. The land in this section is extremely good grass land, and the grass will grow as well in a cornfield as elsewhere unless measures are taken to keep it out. The time required to perform the various operations was similar in the Orleans and Ontario areas. More man hours per acre were required in the Livingston area because of the hoeing. Other operations were performed in less time in the Livingston area than in the other areas because of the larger acreages grown per farm. The hours required to harvest an acre and a ton of corn, and the cost per ton, are given in table 82:

TABLE 82. AVERAGE LABOR REQUIREMENTS HARVESTING SWEET CORN AND HAULING TO FACTORY IN 1920

	Orleans	Ontario	Livingston
Yield per acre (tons)*	2.2	3.4	2.7
Loads per acre	1.3	2.5	1.8
Distance to factory (miles)	1.8	1.3	2.9
Man hours per acre harvesting	13.6	22.7	20.8
Horse hours per acre harvesting	10.9	15.9	13.0
Truck hours per acre harvesting	....	1.4	....
Man hours per ton harvesting	6.2	6.7	7.7
Horse hours per ton harvesting	5.0	4.7	4.8
Truck hours per ton harvesting	....	0.4	....
Cost of harvesting per ton	$4.78	$4.76	$4.28

* Tons per acre of unhusked corn.

STRING BEANS

New York State leads in the production of string beans for the canning factory. The factories that pack beans are distributed thruout the State. The beans are grown for the most part on land operated by the canning companies. At Albion, in Orleans County, however, the canning company contracts with farmers for beans for canning. Accounts on their bean crop were kept by three farmers in this section in 1920. The average cost per acre of producing the crop on these farms in that year is given in table 83. Efficiency in the use of labor on these farms was probably higher than the average.

TABLE 83. AVERAGE COST OF PRODUCING AN ACRE OF STRING BEANS ON 3 FARMS IN ORLEANS COUNTY, GROWING 22 ACRES, IN 1920

Item	Quantity per acre	Cost per acre	Per cent of total cost
Seed	1.1 bu.	$ 8.64	14.3
Fertilizer	220 lbs.	3.34	5.5
Manure charged to string beans	1.8 tons	3.68	6.1
Labor growing string beans:			
Human	30.6 hrs.	13.18	22.0
Horse	40.5 hrs.	9.91	16.4
Use of equipment	40.5 hrs.	3.32	5.5
Use of tractor	2.7 hrs.	4.74	7.9
Interest on growing costs	....	0.48	0.8
Use of land	....	10.62	17.6
Total growing cost	....	$57.91	96.1
Labor harvesting string beans:*			
Human	2.1 hrs.	$0.95	1.6
Horse	4.2 hrs.	1.04	1.7
Use of equipment	4.2 hrs.	0.35	0.6
Total harvesting cost	....	$2.34	3.9
Total cost of crop	....	$60.25	100.0
Returns from crop	2,432 lbs.	$48.64	....
Price per ton	....	$40.00	....
Cost per ton growing	....	$47.63	....
Cost per ton harvesting	....	1.92	....
Total cost per ton	....	$49.55	....

*No labor for picking the crop was included in the cost, as this was paid by the canning company. The farmer was required to haul the beans to the factory.

The price paid was 2 cents a pound. The average yield was 2432 pounds per acre. The variety was Refugee Wax. These fields were picked only once. After the first picking, disease developed, which spotted the pods and made them worthless for canning. Much better yields of beans have been obtained on these farms in previous years. Sometimes, after the beans

suitable for canning are all picked, a crop of ripe beans can be harvested for seed. The disease present in 1920 made this impossible on these farms.

LIMA BEANS

Lima beans are not grown extensively in New York. In northeastern Genesee County they are grown to be used by the local canning company. Accounts were kept by four farmers in this section on their lima-bean crop in 1920. The average cost of producing one acre of lima beans in 1920 on these farms is given in table 84. Efficiency in the use of man labor on these farms was probably higher than the average.

The labor growing lima beans was very similar to that on string beans except that less hoeing was done. The beans were harvested with bean pullers and drawn to the factory, where they were threshed. The roughage was kept by the factory.

TABLE 84. AVERAGE COST OF PRODUCING AN ACRE OF LIMA BEANS ON 4 FARMS IN GENESEE COUNTY, GROWING 12 ACRES, IN 1920

Item	Quantity per acre	Cost per acre	Per cent of total cost
Seed	0.6 bu.	$ 5.72	8.3
Fertilizer	17 lbs.	0.25	0.4
Manure charged to lima beans	4.1 tons	6.92	10.1
Labor growing lima beans:			
Human	23.0 hrs.	10.45	15.2
Horse	57.2 hrs.	14.00	20.5
Use of equipment	57.2 hrs.	4.69	6.8
Interest on growing costs	.....	0.91	1.3
Use of land	.....	10.25	15.0
Total growing cost	.....	$53.19	77.6
Labor harvesting lima beans:			
Human	15.3 hrs.	$7.26	10.5
Horse	22.3 hrs.	5.46	8.0
Use of equipment	22.3 hrs.	1.83	2.7
Association charges	.....	0.72	1.1
Interest on harvesting costs	.....	0.07	0.1
Total harvesting cost	.....	$15.34	22.4
Total cost of crop	.....	$68.53	100.0
Returns from crop	1,290 lbs.	$77.41	.....
Price per ton	.....	$120.00	.....
Cost per ton growing	.....	$82.47	.....
Cost per ton harvesting	.....	23.78	.....
Total cost per ton	.....	$106.25	.....

PEAS FOR THE CANNING FACTORY

A blank for determining the cost of production of and cultural data concerning peas for the canning factory.

Prepared by the Department of Agricultural Economics and Farm Management, and the Division of Vegetable Gardening (Department of Farm Crops) New York State College of Agriculture at Cornell University, Ithaca, N. Y.

Record for year .... County .... Farm No. .... Tabulating No. ....

Grower's name .... Post Office .... R. D. ....

Canning factory .... Location of viner .... Distance to viner ....

Acres farmed .... Acres of peas planted .... Acres harvested ....

Labor on Peas for the Canning Factory

Operation	Dates	Hours: Total Human	Family: Operator	Family	Hired: Man	Hired	Horse	Tractor Auto Truck
Plowing (Depth)								
Harrowing—spring tooth (times)								
Harrowing—spike tooth (times)								
Disking (times)								
Rolling or planking (times)								
Hauling fertilizer to farm								
Hauling fertilizer to field								
Hauling seed to farm								
Hauling seed to field								
Getting and applying inoculation								
Drilling (variety)								
Drilling (variety)								
Drilling (variety)								
Rolling after drilling								
Hauling and spreading manure (page 2)								
Hauling and spreading lime (page 2)								
Total–growing	X							
Rates per hour—growing	X							
Cost of labor—growing	X							
Harvesting (variety)								
Hauling (trips)								
Harvesting (variety)								
Hauling (trips)								
Harvesting (variety)								
Hauling (trips)								
Extra trips to town or factory about peas.								
Total—harvesting and marketing	X							
Rates per hour—harvesting and marketing	X							
Cost of labor—harvesting and marketing	X							
Total labor on crop	X							

Average length of time lost at viner per load of peas?

Kind of machine used for harvesting peas?

Acres of other crops mown with machine in 1920? Value $ Rate of depreciation %

Repairs purchased in 1920? $

Returns from Peas for the Canning Factory

Variety	Grade	Lbs peas and vines	Lbs shelled peas	Tons of shelled peas	Price	Value	Checks from Company	Value
							Date 1	
							2	
							Deduction for	
							bu. seed	
Total								

Miscellaneous returns	Amount	Price	Value
Green vines fed or sold	tons		
Pea vine silage fed	tons		
Pea vine silage sold	tons		
Dry peas	bu		
Straw from dry peas	tons		
Total	X	X	
Pea vine silage purchased	tons		

Disposal of pea vine silage

Kind of stock	Av'g No	Tons fed to
Dairy cattle		
Steers		
Sheep		
Lambs fattened		
Total fed		

Charge made by canner per ton?

Average yields

Year	Acres	Yield per acre	Notes on variety, soil, weather, etc.
1920			
1919			
1918			
1917			
1916			
Average			

Causes of Loss in Yield

Description	Extent of loss	Control measures
Weather	tons	
Insects	tons	
Diseases	tons	
	tons	

Growers Experience with Varieties

Variety	Yield	Uniformity of ripening	
Alaska			

Crops 1920	Acres
Beans	
Peas	
Tomatoes	
Sweet Corn	
Cabbage	
Potatoes	
Corn for grain	
Corn for silage	
Oats	
Winter Wheat	
Hay	
Orchard	
Total	

Rotation on Land in Peas for the Canning Factory

Year	Acres	Crop	Acres	Crop	Acres	Crop
1921						
1920	Soil type	Variety	Soil type	Variety	Soil type	Variety
1919						
1918						
1917						

Expenses on Peas for the Canning Factory

Seed	Variety	Acres Seed	Acres	Bu. per acre	Bushels	Price	Value
Total							
Fertilizer	Kind		Acres	Lbs. per acre	Pounds	Price	Value
Total							

Manure		Tons		Hours of Labor on Manure			% to	Tons to		
Year	Acres	per acre	Tons	Man	Horse	Truck	Crop	Crop	Price	Value
1920										
1919										
1918										
1917										
Total										

Lime			Tons		Hours of Labor on Lime			% to	Tons to		
Year	Acres	Kind	per acre	Tons	Man	Horse	Truck	Crop	Crop	Price	Value
Total											

Miscellaneous Expenses	Amount	Price	Value
Inoculation			
Total growing	X		
Total harvesting	X		

Use of Land for Peas

	Owned	Share	Cash	Total
Acres				
Value per acre	$	$	$	$
Total value	$	$	$	$
Annual cost in % of value	%	%	X	X
Rental for land in peas	$	$	$	$
Other expenses on rented land	X	X	$	$
Total charge for use of land	$	$	$	$

Peas intercropped in	Total acres	Equivalent acres

For peas grown on shares record the tenant's and landlord's share of the following

	Tenant	Landlord
Seed		
Fertilizer		
Man Labor		
Horse Labor		
Equipment Costs		
Land Costs		
Peas		
Roughage		

Use of Buildings for Peas

Value	$
Per cent. of annual use for peas	%
Value of % used for peas	$
Annual cost in % of value	%
Charge for use of buildings	

What were buildings used for?

Comparitive success of seedings with these crops of (if seedings with peas=100)			Hours required to fit an acre for wheat after these crops			Yields of wheat after these crops	Crop seeded in 1920 with peas?
Crop	Alfalfa	Timothy and clover	Man	Horse	Tractor		
Peas	100	100				bu.	
Barley						bu.	Rates of seeding?
Oats						bu.	
Wheat						bu.	
Beans	X	X				bu.	

What other farm operations did work on peas conflict with?

What crops have peas taken the place of in your rotation?

Summary—Costs and Returns

	Total		Per acre		Per ton	
	Amount	Value	Amount	Value	Amount	Value
Seed	bu.		bu		bu.	
Fertilizer	lbs.		lbs.		lbs	
Manure	tons		tons		tons	
Lime	tons		tons		tons	
Labor—growing	X	X	X	X	X	X
Total—human	hr.		hr.		hr.	
Horse	hr.		hr.		hr.	
Equipment	hr.		hr.		hr.	
Tractor	hr.		hr.		hr	
Auto						
Truck						
Miscellaneous expenses—growing	X		X		X	
Interest on growing costs	X		X		X	
Use of land	acres		1 acre		acres	
Use of buildings	X		X		X	
Total cost—growing	X		X		X	
Labor—harvesting and marketing	X	X	X	X	X	X
Total—human	hr.		hr		hr.	
Horse	hr.		hr.		hr.	
Equipment	hr.		hr.		hr.	
Auto						
Truck						
Miscellaneous expenses—harvesting and marketing	X		X		X	
Interest on harvesting and marketing costs	X		X		X	
Use of buildings	X		X		X	
Total cost—harvesting and marketing	X		X		X	
Total cost—crop	X		X		X	
Miscellaneous receipts	X		X		X	
Net cost of shelled peas	X		X		X	
Shelled peas sold to factory	tons		tons		1 ton	
Profit or loss	X		X		X	

Record taken by Date

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The Cabbage Maggot, with Special Reference to Its Control

Glenn W. Herrick and Wallace Colman

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CONTENTS

THE CABBAGE MAGGOT, WITH SPECIAL REFERENCE TO ITS CONTROL

Chortophila brassicae Bouché

Order, *Diptera* Family, *Anthomyiidae*

GLENN W. HERRICK AND WALLACE COLMAN

The cabbage maggot, introduced into this country from Europe early in the nineteenth century, is a pest of long standing. During the summer of 1894 Professor M. V. Slingerland, then entomologist of this experiment station, made a brief investigation of the life history of the maggot and the injuries it produces, and particularly of its ravages on Long Island. In this investigation Professor Slingerland brought together the many scattered facts recorded about this pest and combined these with the new facts gained by his own observations, publishing the whole as Bulletin 78 of the Cornell University Agricultural Experiment Station (Slingerland, 1894). Among the many materials that had been recommended for the control of the cabbage maggot Slingerland mentioned corrosive sublimate, and remarked, "We have but little faith in its effectiveness, but it should be further tested." It is particularly gratifying to the writers, therefore, that after an interval of nearly thirty years they have been able to carry out Professor Slingerland's suggestion that this material should be further tested. The tests, however, have given results which are not in keeping with his lack of faith in the material, but which, on the contrary, have shown that corrosive sublimate promises well as a successful agent of control for the cabbage maggot.

ECONOMIC IMPORTANCE

In general, the cabbage maggot is a pest of northern latitudes. For example, in the United States no injurious outbreaks have been reported south of Pennsylvania, Ohio, and Illinois. On the other hand, the maggot is a serious pest throughout New England and the northern tier of States, and throughout at least the southern part of Canada.

As with other insect pests, the injuries of the cabbage maggot vary from year to year. In some years the outbreaks are very serious, whole crops being completely destroyed; while in other years the injuries are hardly noticeable. In New York State the insect has been especially noticeable in the trucking regions about the large cities. In some cases growers have abandoned the raising of early cabbages. The maggots are particularly injurious to radishes, to early cabbages in the field, and to late cabbage plants in the seedbeds, which are grown for the late crop. They attack cauliflower also, and constitute an important source of injury to this vegetable. While the seriousness of the pest varies from year to year, it is ever present and undoubtedly takes its toll every season.

Nature of injuries

The injuries of the cabbage maggot are confined to the larval stage. The maggots burrow in the stems and the roots of the host plants, destroying the epidermis and the tissues and absorbing the juices. Often they merely make shallow grooves on the surface of the underground parts of the stem or on the roots, destroying mainly the epidermis. Oftener, however, they burrow their channels deeper into the cortex just beneath the epidermis. In the case of young cabbage plants the maggots may burrow upward into the stem above ground and even into the larger leaf stems. Severely injured roots often decay and disintegrate. If a cabbage plant is badly infested, it turns a sickly bluish color and there is a tendency for it to wilt and topple over under the hot rays of the sun.

FIG. 1. A RADISH CUT IN SECTION TO SHOW THE BURROWS OF THE MAGGOT

In the case of radishes, the tubers are often channeled through and through with the small brown burrows of the maggots (fig. 1). Usually the white tissues of badly infested tubers become blackened and eventually decay to a greater or less extent, becoming wholly unfit for table use. Radishes, unless very badly infested, do not usually wilt down as do cabbage plants.

The first indication of the presence of the maggot in cabbages is a noticeable retardation in the growth of the plants. This retardation of growth is very noticeable where unprotected plants are growing alongside of a field of protected plants. Although the maggots may be too few to cause wilting, yet, if any are present, they are taking their toll from the nutrient juices of the plants and the growth is being retarded. The authors believe that in many cases, perhaps in most cases of infestation, *the damage caused by the maggots does not consist so much in the number of plants actually killed as in the number of plants retarded in their growth.* In the growing of cabbages for the early market this is a very important phase of injury, as the results of these experiments clearly show.

LIFE HISTORY

So far as the writers have been able to determine, in the vicinity of Ithaca the cabbage maggot passes the winter as a puparium in the soil. No evidence indicating that the adults hibernate was obtained. Schoene (1916) says, in regard to hibernation, that his observations " indicate that about Geneva, New York, practically all of the insects winter as puparia and that the adults do not hibernate." On the other hand, it is possible that on Long Island adults may hibernate, and Smith (1896) believes there can be no question that in New Jersey the winter is passed in the adult stage.

Appearance of the flies in spring

At Ithaca in 1922 the first flies were taken on May 3 in a sheltered ravine a short distance from a field where cabbages had been grown the previous year. These flies had evidently recently emerged from puparia and were all males. The first females were taken on May 10. (Fig. 2.)

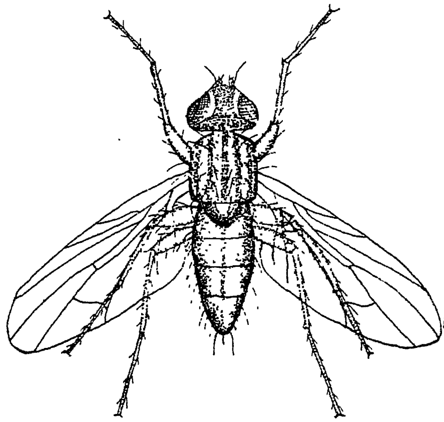

FIG. 2. THE CABBAGE MAGGOT FLY

An attempt was made to correlate the appearance of the flies in the spring with the blooming of some common fruit, and plums were taken as an example. In the spring of 1922 the common varieties of plums bloomed on the following dates: Abundance, May 3; Burbank, May 3; German Prune, May 6; Shropshire Damson, May 6; Bradshaw, May 7.[1] It would appear, from the observations of this one season, that one may look for the first-brood flies to appear during the period over which the common varieties of plums are in bloom. If this should prove true throughout a series of years, the blooming of plums would serve as a guide for the application of control agents.

Deposition of eggs

The tiny white eggs (fig. 3) are deposited generally within a radius of two inches from the stalk of the cabbage. They are sometimes laid on top of the ground, sometimes under or between clods of earth, sometimes in crevices in the soil; but usually they are placed in the space around the stalk which is formed by the action of the wind on the plant.

FIG. 3. EGGS OF THE CABBAGE FLY, × 12

Occasionally the eggs are found stuck to the stalk of the plant just above the surface of the ground. They are seldom found more than one-half inch below the surface. In 1922 the largest number of eggs were laid between May 15 and May 20, and many females were observed ovipositing during this period.

The larva

The larva is a footless maggot (as shown on the front page), shining white in color, sometimes tinged with yellow. It is from one-quarter to one-third of an inch in length when full-grown. It takes, on an average, about three weeks to complete its growth. Under favorable circumstances many of the maggots will mature in less time, especially those of the spring brood. The period of growth tends to be prolonged in cooler weather.

[1] The blooming time of these varieties was furnished by Dr. W. H. Chandler, of the Department of Pomology at Cornell University.

The pupa

When ready to pupate, the maggot usually migrates from the infested plants into the surrounding soil. The puparia (fig. 4), particularly those of the spring brood, are nearly always found within a radius of about three inches from the infested plant and at a depth not greater than three inches. Rarely a puparium is found within the tissues of an injured plant, oftener in radishes than in cabbages. Most of the first-, or spring-brood, puparia occupy a period of about fifteen days for their development. Those of the hibernating brood in the fall, of course, remain for several months in the pupal stage.

FIG. 4. PUPAE, × 6

Emergence of the flies of the first two broods

The periods during which the first two broods developed at Ithaca in the season of 1922 are shown graphically in figure 5. As already mentioned, the flies of the overwintering brood began to emerge on May 3 and were present in considerable numbers from May 10 to May 22. The flies of the succeeding brood emerged almost daily from June 20 to July 17 in outdoor breeding cages. These flies were reared from eggs, larvae, and pupae of the first brood, so that there is no doubt as to which brood they belonged to. The earliest date on which eggs of the second brood were found in the field was July 2.

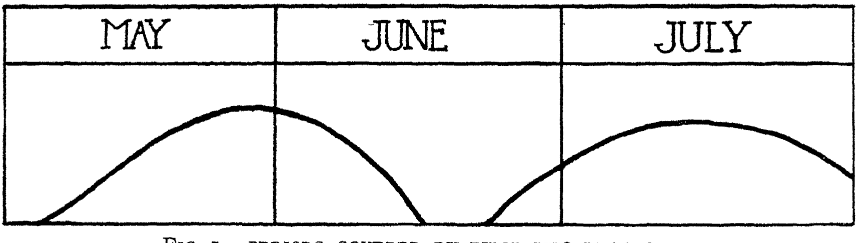

FIG. 5. PERIODS COVERED BY FIRST TWO BROODS

CONTROL

No satisfactorily effective method of control of the cabbage maggot has been available in this country previous to the last three or four years. The insect has in most cases had its own way, and has been subject only to natural agencies which in some seasons have held it in check and in

other years have apparently offered no restraint to its increase and activities. In North America the first extended experimental trials of corrosive sublimate to control the maggot were made by Gibson (1920) in Ottawa and Brittain (1920) in Nova Scotia. For several seasons prior to 1920, both of these investigators used corrosive sublimate in an experimental way with excellent results, which gave them increasing confidence in its value as a control agent for the maggot. They both make acknowledgment of the suggestion regarding its possible value given by Slingerland in 1894.

In the spring of 1921 the senior author began the experimental use of corrosive sublimate in the control of the maggot on radishes, which was continued during the season of 1922. Additional experiments on a larger scale were planned by the writers, and were carried out during the season of 1922 on radishes and cabbages with rather satisfactory results.

What corrosive sublimate is

Corrosive sublimate, known technically as *corrosive chloride of mercury*, is a fine, white, heavy powder, which, when taken in sufficiently large doses by human beings, produces all the effects of a violent corrosive poison — nausea, vomiting, convulsions, death. It is also highly caustic, or corrosive, when applied to the skin. It is sometimes used externally to "burn" out ulcers and diseased areas of flesh. In fact, cases of poisoning from external applications are known. Because of its poisonous and corrosive qualities, it should be stored in plainly labeled containers and placed where children and careless individuals cannot gain access to it. It does not lose its effective qualities when exposed to the air, and therefore does not deteriorate in storage. It dissolves slowly and with some difficulty in cold water, but readily in hot water. It tends to corrode metals, and therefore glass, earthenware, or wooden vessels should be used in the preparation and storage of the diluted solution for field operations. Corrosive sublimate may be procured from almost any druggist, and should cost not more than from $2 to $2.50 a pound, depending on the quantity purchased. It may be obtained, if desired, in small quantities for the treatment of a few garden radishes, in the form of blue tablets ready for dilution at the rate of 1 to 1000 (one tablet to one pint of water).

Experiments on radishes in 1921

Two rows of radishes, each row about 25 feet long, were sown in late April in the senior author's garden, in 1921. On May 7 the plants had come well through the ground and each bore the first pair of leaves. One row was treated on that date with corrosive sublimate at the rate of 1 to 1000 parts of water (1 ounce to 8 gallons). The solution was applied with a watering pot, with the rose removed and the opening partly plugged with a stick so that the water would not flow too freely. The solution was poured directly on the plants and the ground was fairly well wetted about the stems. Eight days later, on May 15, a second application of the same proportions was made in the same way. On June 3 the radishes in both the treated and the check row were harvested and each one was carefully examined for injuries from the maggot. The following table gives the results in concise form:

Row	Date of first treatment	Date of second treatment	Number of radishes free from maggot injury	Number of radishes injured by maggots	Per cent of radishes free from maggot injury
Treated........	May 7	May 15	77	0	100
Check.........	....	....	61	14	81+

One hesitates to record perfect results with any control material, but the facts are as given; not a single radish in the treated row was injured, while nearly 20 per cent of those in the check row had been attacked. The infestation, however, was a light one. No injury to the plants by the liquid was noted during this season.

Experiments on radishes in 1922

Two rows of radishes, about 25 feet long, were sown in the first part of May of 1922. On May 16 and on May 24, one of these rows was treated with corrosive sublimate in solution, at the rate of 1 to 1000 as in the previous season. On June 12 the radishes were harvested and each one was examined carefully for injury. The following table shows the results in brief:

Row	Date of first treatment	Date of second treatment	Number of radishes free from maggot injury	Number of radishes injured by maggots	Per cent of radishes free from maggot injury
Treated.......	May 16	May 24	116	0	100
Check.........	....	....	85	35	70+

Again the treated row produced only uninjured radishes, while the untreated row showed slightly over 29 per cent of the tubers injured by the maggot, a somewhat higher infestation than the year before.

For the first time, slight injury was noted to the leaves of the plants in the treated row. The leaves of these plants were slightly burned and whitened about the edges. The injury, however, did not seem to be of any great moment; the plants soon recovered from the effect, and there was no evidence that the tubers were dwarfed or injured in quality.

A plot of ground in the college vegetable gardens, where the maggots had been abundant and seriously injurious for several years, was selected for another trial. On May 23 eight rows of radishes of the White Icicle variety were sown, each row being about 30 feet long. The corrosive sublimate solution was applied in the same way as in the former tests, and the ground was thoroughly soaked about the stems of the plants. The number of applications, strengths of solution, and results of the treatments, are shown in the following table:

Row no.	Solution	Number of treat-ments	Number of radishes free from maggot injury	Number of radishes injured by maggots	Per cent of radishes free from maggot injury
1	1 oz. to 10 gals. water..	4	60	34	63.8
2	Check................	0	18	82	18.0
3	1 oz. to 10 gals. water..	5	92	15	86.0
4	Check................	0	9	93	8.8
5	1 oz. to 12 gals. water..	4	45	35	56.2
6	Check................	0	7	88	7.4
7	1 oz. to 12 gals. water..	5	80	19	80.8
8	Check................	0	9	52	14.7

The radishes had been sown late and the infestation was very severe, particularly adverse conditions being thus afforded for the corrosive sublimate to work against. The treatments were given once each week, beginning on June 1. The results showed (1) that five applications, one each week during the growing period of the plants, were more efficient than four applications; (2) that a strength of 1 ounce to 10 gallons of water was more effective than the weaker solution of 1 ounce to 12 gallons.

It was found in this case also that if the solution strikes the leaves, some burning may result which may slightly retard growth of the plants. Caesar and Huckett (1920) found that when corrosive sublimate is applied to young plants in a stronger solution than 1 to 1000 (1 ounce to 8 gallons), it "weakens them and causes a distinct shock, though they soon outgrow this."

As a whole, these experiments indicate that strengths of 1 ounce to 8 gallons and 1 ounce to 10 gallons may be applied to radishes, if ordinary care is used, without serious injury to the plants; and that either strength will control the cabbage maggot satisfactorily, even in high infestations, if applied once a week during the growing period, the first application being made as soon as the plants have come well through the ground.

Observations of the effect of corrosive sublimate on cabbages in 1921

During the season of 1921 an excellent opportunity was given in the college vegetable gardens to see the effect of corrosive sublimate on cabbages growing beside those that had received no treatment for the cabbage maggot. The main field of cabbages in the gardens was treated twice with corrosive sublimate at the rate of 1 to 1000 (1 ounce to 8 gallons of water), the first time a few hours after the plants were set in the field and the second time about one week later. The stand of plants was almost perfect, but here and there a stunted plant showed the effects of maggot injury. In a careful examination of this field, 96 per cent of the plants showed exemption from attack.

In contrast to this field were the plots of cabbages grown by students, these plants having received no preventive treatments of any kind. The following records from one student plot made at the time will give a fair idea of the average conditions on these plots. From 14 to 31 per cent of the plants were missing in most of the rows, having been totally

Row no.	Number of plants set	Number of plants missing	Number of scrub plants
1	29	0	3
2	29	4	4
3	29	8	2
4	29	9	2

destroyed; while a considerable proportion of those remaining were stunted and constituted only scrub plants nearly worthless in most cases.

Experiments on cabbages in 1922

In the spring of 1922, careful plans were made by the authors for a series of experiments with corrosive sublimate for the control of the maggot on cabbages. The Division of Vegetable Gardening at the College furnished the ground for the plants, cultivated them thoroughly throughout the season, and aided in the harvest.

FIG. 6. A GENERAL VIEW OF THE EARLY-CABBAGE PLOTS

The plants were set on a piece of ground 75 feet long by 60 feet wide, just about $\frac{1}{10}$ of an acre (fig. 6). They were set in rows $2\frac{1}{2}$ feet apart, and were 18 inches apart in the rows. There were 24 rows, each containing 50 plants of the Copenhagen Market variety. The 1200 plants were set in the field on May 2 and were given the first treatment three days later, on May 5. There were 600 plants under treatment, while 600 were retained as checks and received no treatment. The exact arrangement of the plot, the strengths of solution used, the time of applications, and

partial results of the different treatments, are shown in the following table:

Row no.	Solution	Number and dates of treatments	Number of plants killed by maggots	Number of plants dead from other causes	Total dead plants
1	1 oz. to 8 gals. water...	Two, May 5, 12	0	0	0
2	Check................	....	3	0	3
3	1 oz. to 8 gals. water...	Three, May 5, 12, 20	0	0	0
4	Check................	....	5	0	5
5	1 oz. to 10 gals. water..	Two, May 5, 12	0	0	0
6	Check................	....	2	0	2
7	1 oz. to 10 gals. water..	Three, May 5, 12, 20	0	1	1
8	Check................	....	0	0	0
9	1 oz. to 12 gals. water..	Two, May 5, 12	0	0	0
10	Check................	....	3	0	3
11	1 oz. to 12 gals. water..	Three, May 5, 12, 20	0	0	0
12	Check................	....	2	0	2
13	1 oz. to 8 gals. water...	Two, May 5, 12	0	0	0
14	Check................	....	8	0	8
15	1 oz. to 8 gals. water...	Three, May 5, 12, 20	0	0	0
16	Check................	....	1	0	1
17	1 oz. to 10 gals. water..	Two, May 5, 12	0	0	0
18	Check................	....	0	0	0
19	1 oz. to 10 gals. water..	Three, May 5, 12, 20	0	0	0
20	Check................	....	2	0	2
21	1 oz. to 12 gals. water..	Two, May 5, 12	0	0	0
22	Check................	....	5	0	5
23	1 oz. to 12 gals. water..	Three, May 5, 12, 20	1	0	1
24	Check................	....	7	0	7

It will be noted that in only one case in the treated rows did a plant die from injury by maggots. A single plant was lost in one of the rows receiving treatment with a solution at the strength of 1 ounce to 12 gallons of water. In the untreated rows the losses ran from none, in two instances only, up to eight in the worst row.

The season was unusually wet, and had it not been for timely rains the authors feel sure that many more plants would have died in the untreated rows. Frequent and copious showers enabled many plants injured by the maggots in the untreated rows to grow in spite of the injury and to overcome the effects to a considerable extent.

The most striking result of the experiments was the effect which the corrosive sublimate exerted on the plants in hastening their growth and in bringing the cabbages to maturity in time for the early market when the price was high. Here again the authors believe that, had the season been a dry one, the difference between the treated and the untreated rows would have been even greater, because the untreated plants injured by the maggots would not have made nearly as much growth as they did and in many cases would probably not have matured any heads at all.

In general, the plants in the treated rows developed a much better root system than did those in the untreated rows. This is well illustrated in

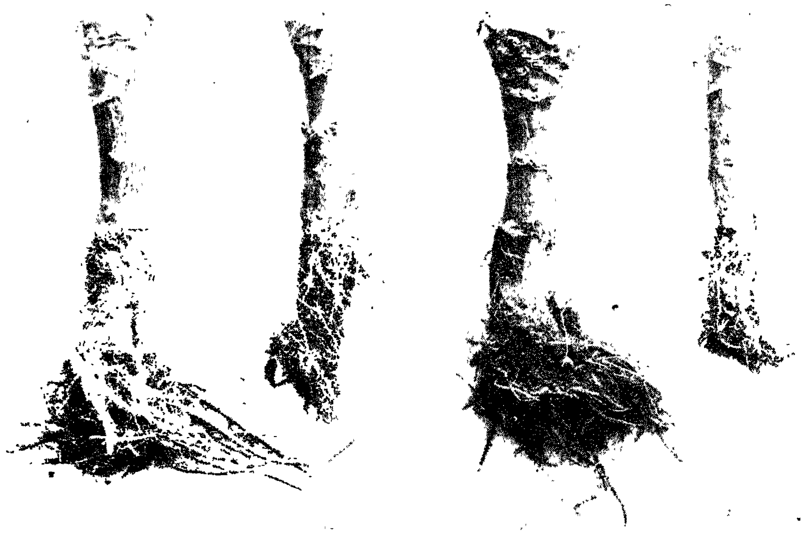

FIG. 7. ROOTS OF AVERAGE CABBAGE PLANTS FROM TREATED AND FROM CHECK ROWS AT HARVESTING TIME

The first and the third are from treated rows: the second and the fourth are from check rows

figure 7, which shows the roots of representative plants at the time of harvesting.

The actual number of heads produced under the different treatments and maturing on different dates, and their weights, are shown in the following table:[2]

Row no.	Solution	Number of treatments	Cabbages harvested on July 11, price 4 cents		Cabbages harvested on July 19, price 2 cents		Cabbages harvested on July 31, price 1½ cents	
			Number of heads	Total weight (pounds)	Number of heads	Total weight (pounds)	Number of heads	Total weight (pounds)
1	1 oz. to 8 gals. water....	2	16	40	16	45	16	43
2	Check.......... ...	0	3	2.75	12	22.5	21	39
3	1 oz. to 8 gals. water....	3	9	22	20	48	19	41
4	Check.....	0	5	11	12	24	23	43
5	1 oz. to 10 gals. water...	2	11	28.5	27	53	13	23
6	Check..........	0	8	14	11	17.5	23	39 5
7	1 oz. to 10 gals. water...	3	11	24	16	31.5	20	40
8	Check....	0	5	8 25	9	15.5	29	54
9	1 oz. to 12 gals. water ...	2	8	17.5	17	31.25	21	39
10	Check....	0	4	8	11	26.5	23	50
11	1 oz. to 12 gals. water....	3	11	23.5	16	32	20	40
12	Check.......	0	3	4.5	9	17.5	23	39
13	1 oz. to 8 gals. water...	2	4	10	18	37	24	46
14	Check..........	0	4	6	12	19.25	20	33
15	1 oz. to 8 gals. water....	3	6	15	21	48.5	22	52
16	Check..........	0	1	2	9	18.25	32	61
17	1 oz. to 10 gals. water ...	2	11	21	22	40.5	17	24
18	Check.........	0	6	12.5	9	17.75	25	53
19	1 oz. to 10 gals. water....	3	9	22	12	35.5	26	58
20	Check........	0	4	8	13	26	23	49
21	1 oz. to 12 gals. water....	2	4	8	25	55.25	18	35
22	Check....	0	2	5	14	30.5	26	51.5
23	1 oz. to 12 gals. water....	3	7	15	21	53.75	19	46
24	Check.......	0	8	16.25	20	47 25	10	24

[2] No heads were gathered after July 31, as the price did not warrant it.

It will be noted that on July 11, when the price of cabbages was 4 cents a pound, the treated rows gave in general, from two to five or more times as many marketable heads as did the untreated rows. Moreover, in most cases, the heads from the treated rows averaged considerably higher in weight than those from the untreated rows (fig. 8). Also, on July 19,

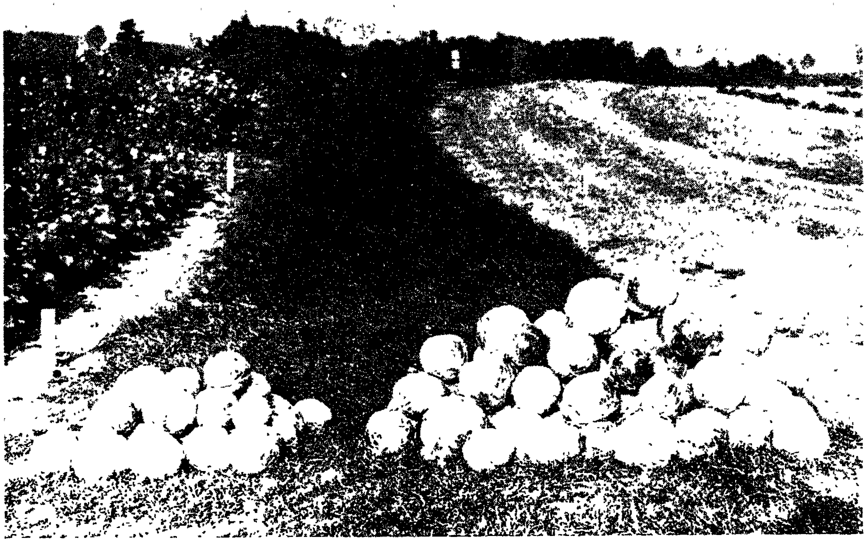

FIG. 8. CABBAGES HARVESTED FROM CHECK AND FROM TREATED ROWS
The cabbages in the smaller pile were harvested from check rows 2, 4, 6, 8, 10, and 12, on July 11. Those in the larger pile were harvested from treated rows 1, 3, 5, 7, 9, and 11, on the same date.

when the price was 2 cents a pound, a much larger number of marketable heads were available from the treated than from the untreated rows.

The total number of heads harvested from the treated and from the untreated rows, with their total weight and value, is shown in the following table:

	Heads harvested on July 11			Heads harvested on July 19			Heads harvested on July 31		
	Number	Weight (pounds)	Value at 4 cents a pound	Number	Weight (pounds)	Value at 2 cents a pound	Number	Weight (pounds)	Value at $1\frac{1}{2}$ cents a pound
Rows treated with corrosive sublimate 1 to 8	35	87	$3.48	75	178.5	$3.57	81	182	$2.73
Rows treated with corrosive sublimate 1 to 10	42	95.5	3.82	77	160 5	3.21	76	145	2.18
Rows treated with corrosive sublimate 1 to 12	30	64	2 56	79	172 25	3.45	78	160	2.40
Totals for treated area..	107	246.5	$9.86	231	511.25	$10.23	235	487	$7.31
Untreated area (check)..	53	98.25	$3 93	141	282.5	$5.65	278	536	$8.04

Total number of heads harvested on treated area	573
Total weight of cabbages on treated area	1,244.75 pounds
Total value of cabbages on treated area	$27.40
Total number of heads harvested on untreated area	472
Total weight of cabbages on untreated area	916.75 pounds
Total value of cabbages on untreated area	$17.62

It will be noted that the treated rows produced 101 more heads and 328 more pounds of cabbages than the untreated rows. Moreover, a much larger proportion of the heads in the treated rows matured early and were marketed while the price was high. Thus the treated area gave a total income about 1½ times greater than that from the untreated area.

When it is considered that about $\frac{1}{20}$ of a treated acre produced 328 pounds more of cabbage than was produced on an equal area untreated, it is plain that an acre of cabbages receiving two or three applications of corrosive sublimate will at the same rate produce 6560 pounds of cabbage, having a value of approximately $190, in excess of the cabbage produced on an untreated acre. This gives a very satisfactory margin of profit, even though three applications of corrosive sublimate, costing $25 an acre, are made. Moreover, the satisfaction of growing a clean, thrifty crop of cabbages is worth a good deal.

The cost of treating with corrosive sublimate an acre of cabbages containing 12,000 plants is shown in the following table:

Solution	Number of treatments	Pounds of corrosive sublimate to an acre	Gallons of solution to an acre	Time required to make the applications* (hours)	Total cost per acre†
1 oz. to 8 gals. water.......	2	3 1/8	400	40	$18.25
1 oz. to 8 gals. water.......	3	4 11/16	600	60	27.38
1 oz. to 10 gals. water.......	2	2 1/2	400	40	17.00
1 oz. to 10 gals. water.......	3	3 3/4	600	60	25.50
1 oz. to 12 gals. water.......	2	2 1/12	400	40	16.17
1 oz. to 12 gals. water.......	3	3 1/8	600	60	24.25

* Based on a treatment of 600 plants per hour. (One man can treat from 500 to 1000 plants per hour.)
† Based on corrosive sublimate at $2 a pound, and labor at $3 per day of 10 hours.

Methods of application

Corrosive sublimate does not dissolve readily in cold water, and therefore it is advisable to use hot water or to place the powder in cold water some hours before the solution is needed for use. A fairly satisfactory way to prepare the solution is to place 6 ounces of the powder in a barrel of water (48 gallons) twenty-four hours or more previous to the time when the application is to be made. As many barrels may be prepared as are estimated to be necessary for treating the acreage under cultivation. The barrels of solution may well be distributed at convenient intervals throughout the cabbage field. It would be advisable to cover each one, in order to prevent livestock from drinking the water. Previous to using the solution it should be thoroughly stirred, and the person applying it should be certain that the powder is all dissolved.

The solution may be applied with a pail and a small dipper, about one-fourth of a teacupful being placed on each plant. If desired, a watering pot, with the rose removed and the spout partly plugged with a piece of wood to prevent the water from flowing too freely, may be used in applying

the solution. The object is to *wet the soil about the stem of the plant*, and especially to *fill the opening in the soil immediately about the stem.*

SUMMARY

The cabbage maggot, introduced from Europe early in the nineteenth century, is a destructve pest to radishes, cabbages, cauliflower, and turnips.

It is particularly injurious to early cabbages in the field and to late cabbage plants in the seedbed.

It can be controlled satisfactorily by applications of corrosive sublimate in solution with water at dilutions of 1 ounce to 8 gallons and 1 ounce to 10 gallons.

Radishes may be protected from injury by the maggot with two or three applications of the poison at a strength of 1 ounce to 8 gallons in the case of average infestations, or with an application each week during the growing period of the plants at a strength of 1 ounce to 10 gallons. Slight burning and whitening of the leaves may result if the solution is poured directly over the plants. It is wiser to direct the stream below the leaves and against the stems as much as possible.

Early cabbages in the field may be protected from injury by treatments at intervals of about one week, the first application being made within three or four days after the plants have been set in the field. There seems to be little difference between the effectiveness of a strength of 1 ounce to 8 gallons and one of 1 ounce to 10 gallons. Since, however, there is so little difference in the cost of the two strengths, the former is recommended, especially where the infestation has been severe.

At least two applications should be made, and three would give greater insurance of protection from injury.

Evidence has been obtained which shows that late cabbage plants in the seedbed may be protected from the maggot by weekly applications of corrosive sublimate during the growing period of the plants. The data obtained, however, are not sufficient to serve as a basis for definite recommendations.

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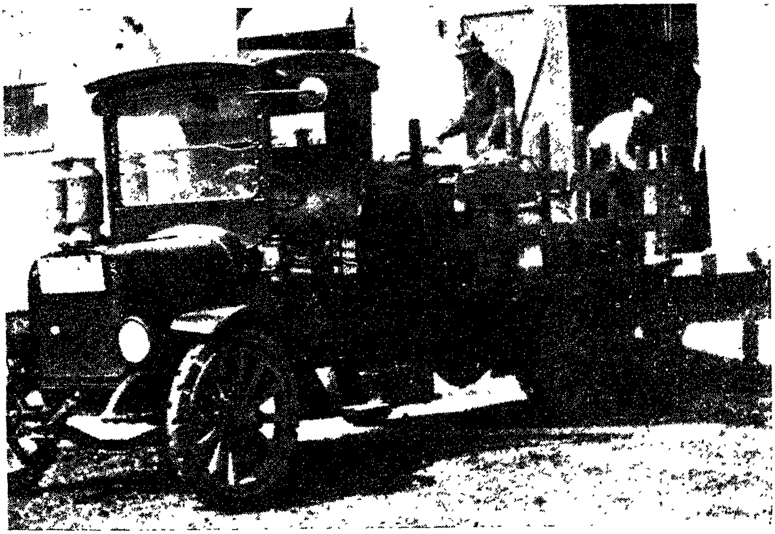
Farm Motor Trucks in New York

V. B. Hart



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CONTENTS

FARM MOTOR TRUCKS IN NEW YORK[1]

V. B. HART

Whenever a new kind of transportation has been developed, attention has first been given to carrying passengers instead of freight. This was true first with the railroads and later with the automobile industry. More than a hundred concerns were making passenger automobiles before the manufacture of trucks was started on a commercial basis.

The construction of the first motor truck in the United States and the development of truck manufacturing from an industry producing less than five hundred machines in 1904 to one that turned out over a third of a million in 1921, has all taken place during the past twenty years. The thirteenth United States census reported 21,692 motor vehicles manufactured in this country in 1904 by establishments engaged in the automobile industry.[2] Of this number, 411 were motor trucks and delivery wagons.

In 1909 automobile manufacturers made 121,868 pleasure and family vehicles and 3228 trucks and delivery cars.[2] Five years later, in 1914, the annual production had risen to 543,679 pleasure and family cars and 23,942 trucks. The 1919 census of manufactures with reference to the automobile industry gives the production of passenger vehicles by automobile manufacturers[3] for that year as 1,557,480, and of trucks and delivery cars as 120,559.

The National Automobile Chamber of Commerce of New York City, from figures furnished by manufacturers, gives the production of passenger cars for 1922 as 2,287,000 and of trucks as 240,000; and the Bureau of Public Roads of the United States Department of Agriculture reported approximately 11,000,000 passenger cars and 1,250,000 trucks registered in this country during 1922.

MOTOR TRUCKS ON FARMS IN THE UNITED STATES

Prior to 1920, there were no complete and reliable sources of information as to the number of motor trucks in use on farms in the United States. Figures collected during that year by the Office of Farm Management and Farm Economics of the United States Department of Agriculture agreed with the common observation that the number of farm trucks had been rapidly increasing during the past five years. Data obtained in connection with a farm motor-truck study made by that office, covering 753 farm trucks scattered thruout New England and the northeastern

[1] Also presented to the Faculty of the Graduate School of Cornell University, June, 1923, as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy.

AUTHOR'S ACKNOWLEDGMENTS. This thesis is based on investigational work done by the author for the New York State College of Agriculture under the direction of Professor G. F. Warren. It was made possible by the cooperation of the many farmers who willingly furnished the essential data and information used. Acknowledgment is due also to the Bureau of Crop Estimates of the United States Department of Agriculture for assistance in obtaining some of the preliminary data. To these and to many others who gave valuable suggestions and assistance, the author expresses his sincere thanks and appreciation.

[2] Thirteenth Census of the United States, vol. 10, Manufactures (1909), p. 816. 1913.

[3] Fourteenth Census of the United States, vol. 10, Manufactures (1919), p. 874. 1923.

States, showed that 84 per cent of the trucks had been in use for three years or less.[4] Similar data from the results of a study of farm trucks in the Corn Belt States showed that less than one per cent of 831 truck owners included in the investigation had owned their trucks for more than three years.[5]

The fourteenth United States census reported 131,551 farm-truck owners in this country in 1920. Two per cent of the farms had trucks.[6] The percentage of farms having trucks varied from 11.5 per cent and 10.4 per cent in Rhode Island and New Jersey, to less than one per cent in many of the Southern States. The distribution of farm-truck owners in the country by States is shown in figure 1 and the percentage of farmers

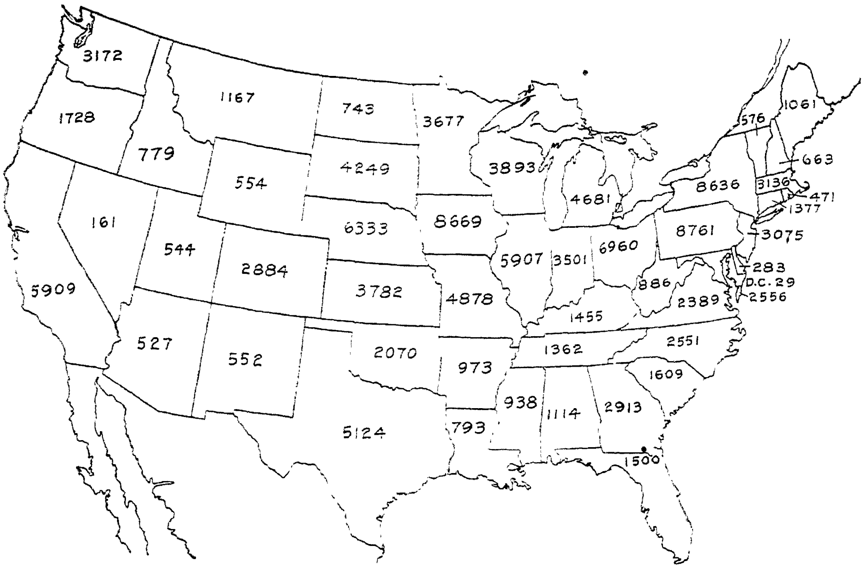


FIGURE 1. NUMBER OF FARM MOTOR-TRUCK OWNERS IN THE VARIOUS STATES, 1920

owning trucks in the different States is shown in figure 2. There were 8636 farm-truck owners reported in New York. This number represented 4.5 per cent of the farms in the State.

Shortage of labor, especially during the World War, and increased costs of maintaining horses and wagons, have probably been the two most important direct factors in increasing the number of trucks on farms. The improvement of state and county highways has been both a cause and an effect of the increase in the number of trucks and automobiles on farms. A good road to market is an added inducement to a farmer to buy a truck, and a truck is an added inducement to him to get the good road. Improvements in the construction of trucks and the standardization of parts,

[4] Experience of eastern farmers with motor trucks. By H. R. Tolley and L. M. Church. U. S. Dept. Agr., Bul. 910, p. 7. 1920.

[5] Corn-Belt farmers' experience with motor trucks. By H. R. Tolley and L. M. Church. U. S. Dept. Agr., Bul. 931, p. 6. 1921.

[6] Fourteenth Census of the United States, vol 6, Agriculture, part 1 (1919), p. 22. 1922.

together with the establishment, in small towns, of sales and service stations for passenger cars, have given truck manufacturers excellent opportunities for increasing their sales among farmers.

PURPOSE OF THIS INVESTIGATION, AND METHODS OF STUDY

In order to make available to farmers of this State information concerning the experience of those who had used trucks in connection with their farm business, the writer started, in 1921, a study of farm motor trucks on New York farms. The object in making the study was to obtain reliable data on the costs of operating farm trucks, and information as to the possibilities and limitations of trucks for farm use. No attempt

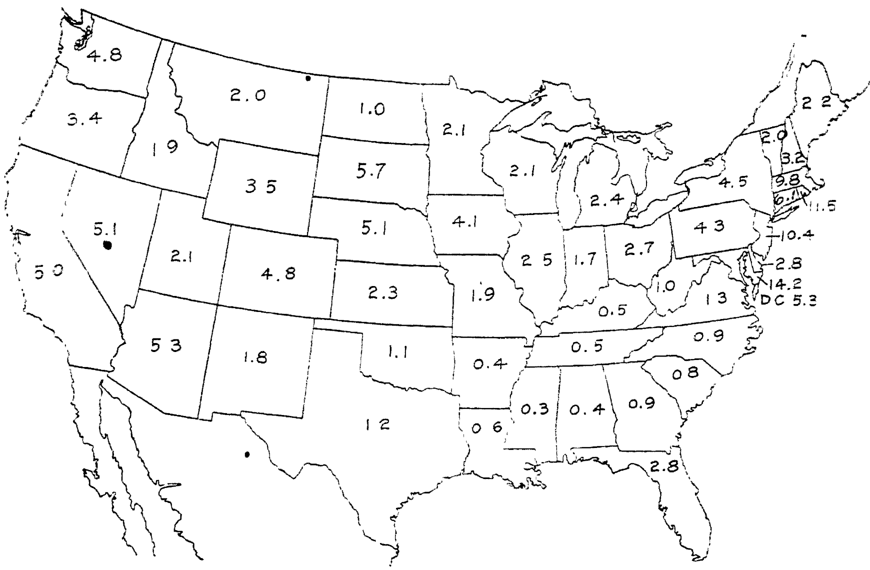


FIGURE 2. PER CENT OF FARMERS OWNING MOTOR TRUCKS IN THE VARIOUS STATES, 1920
(Average for the whole United States, 2 per cent)

was made to prove or to disprove any preconceived opinion as to the efficiency of any particular type or make of truck or the relative values of trucks and horses for farm use.

With the cooperation of the Bureau of Crop Estimates of the United States Department of Agriculture, and the Extension Service of the New York State College of Agriculture, questionnaires asking for names and addresses of farm-truck owners were mailed on June 1, 1921, to all farm bureau committeemen in the State. The 2275 questionnaires which were filled out and returned gave names and addresses of 8417 truck owners.

The questionnaires returned were very evenly distributed over counties containing 94.3 per cent of the farms of the State. Due to loss of mail in transit, complete returns were not obtained from several counties of the State. The Office of Farm Management and Farm Economics of the United States Department of Agriculture ascertained from the crop

reporters of the Bureau of Crop Estimates the number of farm-truck owners in the different counties of the State on January 1, 1920. Reports received by the writer from farm bureau committeemen from all but five of the agricultural counties of the State showed 126 per cent more truck owners on June 1, 1921, than the crop reporters gave for these counties on January 1, 1920.

Assuming that the number of truck owners in the small areas not fully covered by the questionnaires increased at the same rate as in the rest of the State, there would have been 9317 farm-truck owners in New York

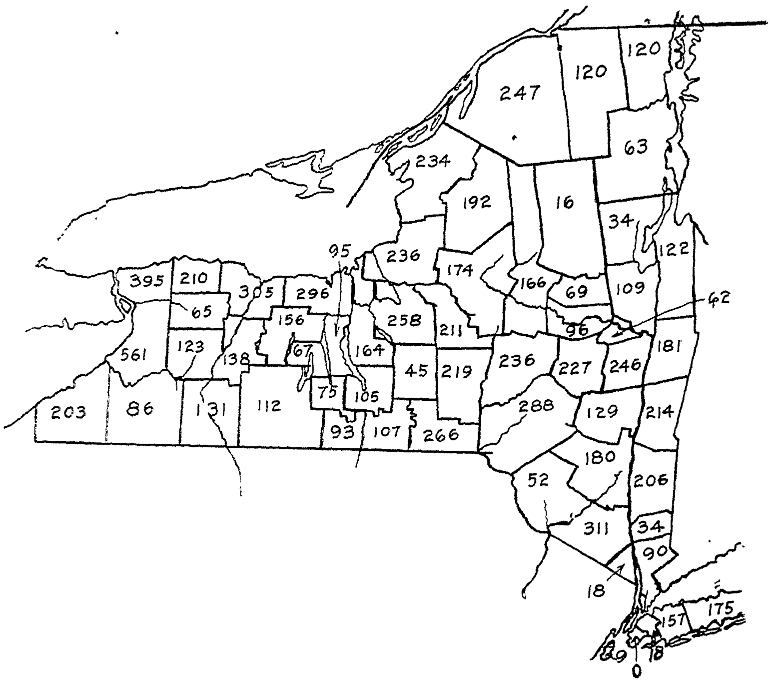


FIGURE 3. DISTRIBUTION OF 9317 FARM MOTOR-TRUCK OWNERS AS REPORTED BY FARM BUREAU COMMITTEEMEN AND CROP REPORTERS, JUNE 1, 1921

on June 1, 1921. In figure 3 the distribution of the farms having trucks is shown by counties, and the percentage of farms having trucks in each county is shown in figure 4.

Counties producing a large amount of perishable products have the greatest percentage of farm-truck owners. The Lake Ontario fruit belt and the fruit section of the lower Hudson River Valley, the garden-truck areas around large cities, and sections producing large amounts of market milk, are the places where one finds the greatest percentage of farmers using trucks. In the six counties [7] of the State which have more than one hundred bearing apple trees per farm, 7.2 per cent of the farmers had trucks as compared to 4.5 per cent for all other counties.

[7] Niagara, Orleans, Monroe, Wayne, Greene, and Columbia. Data from Fourteenth Census of the United States, vol. 6, Agriculture, part 1 (1919), p. 222-227. 1922.

Questionnaire blanks on which information considered essential to a study of this kind could be reported, were mailed to all farm-truck owners whose addresses had been obtained.

Experience has shown that in sending out a questionnaire of this nature, the more questions asked, the smaller will be the number of blanks filled out and returned. However, because of the large number of addresses of motor-truck owners available, the writer decided to use a very complete and detailed blank. No questions concerning the costs of truck operation

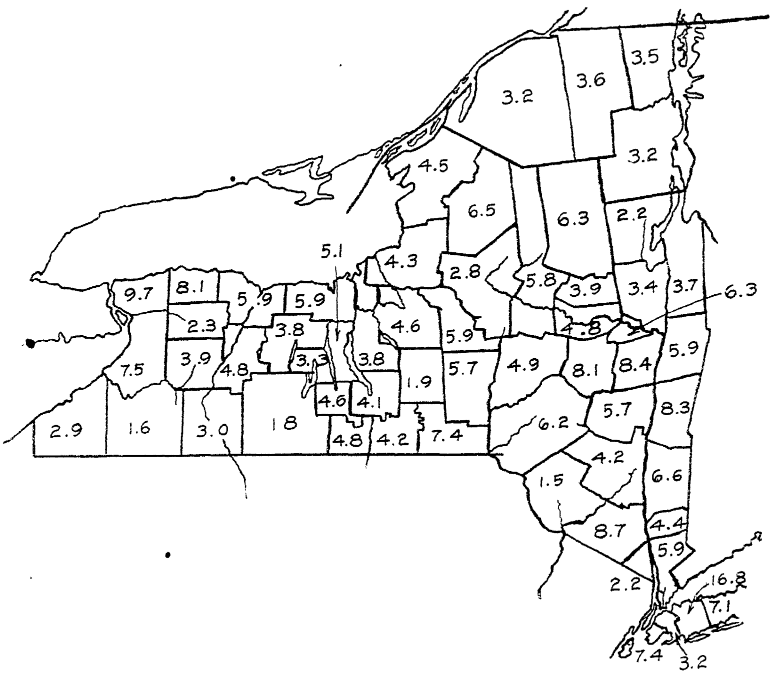


FIGURE 4. PER CENT OF FARMERS OWNING MOTOR TRUCKS IN THE VARIOUS COUNTIES OF NEW YORK, JUNE 1, 1921

(Average for the entire State, 4.8 per cent)

were, however, included in the questionnaire, as it was thought best to get this information by personal investigation.

The questionnaire, a specimen of which is shown on pages 53 and 54, asked for information on more than one hundred points pertaining to farm trucks and their relation and effect on the farm organization. The blanks, filled in, were returned by 562 farmers very evenly distributed over the State. Of these returned questionnaires, 251 were very completely filled out and were from men who had owned their trucks for at least one year. The remaining 311 were either only partly filled out, or were for trucks which had been owned for less than a year. However, some parts of these latter records could be used and certain data from them are included in this work.

In order to get information on the cost of operating trucks, personal visits were made to 103 farmers who owned trucks in the dairy sections of Chenango, Broome, and Delaware Counties, and records of costs were obtained together with data similar to that asked for on the questionnaire. The survey blank used in this work is shown on pages 55 and 56. Of these 103 men, 70 had owned their trucks for one year or more and gave complete records for a year's work. None of the cost data given by the remaining 33 men, who had not owned their trucks for a full year, are included in this study.

DESCRIPTION OF FARMS FROM WHICH INFORMATION WAS OBTAINED BY THE USE OF QUESTIONNAIRES

Questionnaires were returned by farmers from all but four of the agricultural counties of New York. The 251 questionnaires referred to as being selected because of their complete data, represented all of the agricultural regions of the State. The acreages of the various crops grown, and the number of stock kept, on the 247 farms for which this information was furnished, as compared with the average for the State, are shown in tables 1 and 2. The 247 farms were 43 per cent larger than the average as given by the fourteenth United States census, and had 81 per cent more acres of crops than the average farm. They also had 1.2 more work animals than the state average, and 13.7 cows as compared with 7.8, the average for the State. A larger percentage of the total farm area was in crops, and the crops grown were more intensive than those on the average farm. Measured on the basis of the amount of productive

TABLE 1. ACRES OF CROPS GROWN ON 247 FARMS INCLUDED IN THIS STUDY, AS COMPARED WITH THE AVERAGE NEW YORK FARM

	Acres grown on average farm of State*	Acres grown on average of 247 farms
Total farm area	106.8	152.3
Area in crops:		
Alfalfa	0.6	2.5
Barley	0.6	0.8
Beans	0.2	0.8
Buckwheat	1.1	1.4
Corn for grain	1.7	3.6
Corn for silage	1.7	5.4
Hay	24.7	32.0
Oats	4.9	9.0
Potatoes	1.6	4.5
Rye	0.6	1.2
Wheat	2.4	5.9
Orchard	3.3	11.7
Other crops	3.2	5.7
Total crop acreage	46.6	84.5
Per cent of farm area in crops	43.6	55.5

* Data from Fourteenth Census of the United States, vol. 6, Agriculture, part 1 (1919), p. 222. 1922.

TABLE 2. NUMBER OF STOCK KEPT ON 247 FARMS INCLUDED IN THIS STUDY, AS COMPARED WITH THE AVERAGE NEW YORK FARM

Kind of stock	Number on average farm of State[*]	Average per farm of 247 farms
Work horses and mules	2.6	3.8
Cows	7.8	13.7
Young cattle and bulls	3.3	6.3
Hogs	3.1	5.2
Sheep	3.0	8.4
Poultry	55.7	145.0

[*] Data from Fourteenth Census of the United States, vol. 6, Agriculture, part 1 (1919), p. 216. 1922

work represented by the crops and the stock handled, these farmers had businesses 109 per cent larger than the average, and for this reason they were probably producing more than twice as much as the average farm.[8]

These farmers did 5.3 per cent of their road hauling with horses, but they did 14.2 per cent as much trucking for their neighbors as for themselves. Detailed studies made in the dairy section of southern New York showed that the farmers who owned trucks in that area had still larger businesses than the average farm-truck owner of the State. These figures would indicate that, while only 4.8 per cent of the farmers of the State have trucks, because they have larger businesses than the average they are handling at least one-tenth of the agricultural products and farm supplies of the State. In addition, large amounts of farm produce and supplies are moved by commercial truckmen and produce buyers.

DESCRIPTION OF SECTION IN WHICH SURVEY RECORDS WERE TAKEN

The survey records used in this work were taken from farmers in an area which includes approximately the northern half of Broome County, the central and southern parts of Chenango County, and the central and western parts of Delaware County. This area lies along the northern part of the Allegheny plateau and is traversed from north to south by the valleys of the Tioughnioga, Chenango, Susquehanna, and Delaware Rivers. A railroad line runs along each of these valleys. With the exception of the lower half of that part of the Delaware River Valley which is included in this area, an improved highway of either macadam or concrete type parallels each railroad. There are few other improved highways in the area. The average elevation in this section ranges from about 950 feet in the valleys to about 1750 feet on the higher points of the intervening hills. Most of the upland soils belong to the Volusia, Lordstown, Wooster, or Lackawanna series, and the valley soils to either the Fox and Chenango or similar series.

This area receives an average rainfall of about 18 inches for the five months April to August inclusive, and has an average growing season of from 125 to 150 days.

[8] This comparison is based on productive man work units. A productive work unit is the average amount of work required to raise an acre of hay cut once. The average number per farm was 259.0 for the State and 540.1 for these 247 farms.

Owing to the general rough topography of the uplands and the limited amount of fertile valley land available, the type of farming is primarily dairying. A few potatoes and some wheat and buckwheat are raised as cash crops, but the chief product of the section is market milk, a bulky and perishable product which must be delivered daily at a railroad shipping point.

A comparison of the amount of crops and stock on these farms with the average farm of Broome, Chenango, and Delaware Counties is shown in tables 3 and 4. The average of these 70 farms was 59 per cent larger than

TABLE 3. ACRES OF CROPS GROWN ON 70 FARMS HAVING MOTOR TRUCKS IN BROOME, CHENANGO, AND DELAWARE COUNTIES, AS COMPARED WITH THE AVERAGE FARM OF THESE COUNTIES

	Acres grown on average farm*	Acres grown on average of 70 farms having trucks
Total farm area	136.4	216.4
Area in crops:		
Alfalfa	0.03	....
Barley	0.07	0.09
Beans	0.02	....
Buckwheat	1.14	1.58
Corn for grain	0.41	0.54
Corn for silage	1.48	7.03
Hay	33.04	55.67
Oats	3.42	9.06
Potatoes	1.07	1.64
Rye	0.06	....
Wheat	0.18	1.40
Orchard	1.01	0.72
Other crops	1.31	0.61
Total crop acreage	43.24	78.34
Per cent of farm area in crops	31.7	36.2

*Data from Fourteenth Census of the United States, vol. 6, Agriculture, part 1 (1919), p. 222–223. 1922

TABLE 4. NUMBER OF STOCK KEPT ON 70 FARMS HAVING MOTOR TRUCKS IN BROOME, CHENANGO, AND DELAWARE COUNTIES, AS COMPARED WITH THE AVERAGE FARM OF THESE COUNTIES

Kind of stock	Number on average farm*	Average per farm of 70 farms
Work horses and mules	2.4	3.5
Cows	13.6	27.6
Young cattle and bulls	5.4	9.9
Hogs	1.9	1.7
Sheep	1.0	1.2
Poultry	53.0	82.0

*Data from Fourteenth Census of the United States, vol. 6, Agriculture, part 1 (1919), p.216–217. 1922.

the average of all farms in these three counties, and had 27.6 cows as compared with 13.6 for the average farm. About the same proportion of these farms was in crops, but they were more heavily stocked with cattle and they were raising more silage and fodder corn than the average. Measured by the work necessary to handle the crops and stock on these farms, they were 10 per cent larger than the 247 farms in various parts of the State from which similar data were obtained by the use of questionnaires, and were 128 per cent larger than the average farm of Broome, Chenango, and Delaware Counties.

SIZES OF TRUCKS USED AND PREFERRED BY FARMERS

Of the 562 men who returned questionnaires, 556 had only one truck, 3 had two, and 3 had three. The number of trucks of the different sizes used by the 561 farmers who reported this information is shown in table 5. Of these trucks, 44 per cent were of the 1-ton size and 26 per cent were ½-ton

TABLE 5. SIZES OF TRUCKS USED BY NEW YORK FARMERS

Size of trucks	Questionnaire records from all parts of State		Survey records from Broome, Chenango, and Delaware Counties	
	Number of this size	Per cent of total	Number of this size	Per cent of total
½ ton	148	26.0	36	35.0
¾ ton	41	7.2	7	6.8
1 ton	250	43.8	41	39.8
1¼ tons	16	2.8	2	1.9
1½ tons	52	9.1	12	11.7
2 tons	42	7.4	3	2.9
Over 2 tons	21	3.7	2	1.9
Total	570*	100.0	103	100.0

* Three of the men reporting had 2 trucks each and three had 3 each. One did not report the size used.

trucks. Only 21, or less than 4 per cent, of these men were using trucks larger than the 2-ton size. The 103 truck owners from whom survey records were taken had about the same percentage of 1-ton trucks as these 561 farmers, but 35 per cent of their trucks were of the ½-ton size as compared with 26 per cent for the 570 trucks of the men located in various parts of the State.

Two of the questions asked on the questionnaire were, "If you did not own a truck, would you buy one?" and "What size would you get?" The way in which the first question was answered by the men who had owned their trucks for a year or more is shown in table 6. Of the 385 men who gave this information, 361 said that they would buy a truck and 15 that they would not, and 9 stated that they were undecided.

Answers to the second question were given by 345 men, and the sizes of trucks which they preferred are tabulated in table 7. The number of

TABLE 6. REPORTS ON THE QUESTION, "IF YOU DID NOT OWN A TRUCK, WOULD YOU BUY ONE?"
(411 truck owners)

Size of truck owned	Yes	No	Uncertain	No report	Total
½ ton	93	3	4	8	108
¾ ton	24	2	1	1	28
1 ton	160	9	2	9	180
1¼ tons	8	1	1	....	10
1½ tons	38	....	....	3	41
2 tons	21	....	1	4	26
Over 2 tons	17	....	....	1	18
Total	361	15	9	26	411

TABLE 7. SIZES OF TRUCKS PREFERRED BY 345 MEN WHO HAD OWNED THEIR TRUCKS FOR ONE YEAR OR MORE

Size of truck now owned	½ ton	¾ ton	1 ton	1¼ tons	1½ tons	2 tons	Over 2 tons	Total
Number of this size	94	22	153	7	32	20	17	345
Number of men preferring each size:								
½ ton	28	....	2	....	....	....	....	30
¾ ton	8	6	1	....	....	....	....	15
1 ton	47	9	107	....	6	1	....	170
1¼ tons	....	3	4	3	....	....	1	11
1½ tons	5	3	26	1	12	2	1	50
2 tons	6	1	8	3	10	13	1	42
2½ tons	....	....	2	....	4	1	5	12
3 tons	....	....	2	....	....	2	5	9
3½ tons	....	....	1	....	....	1	1	3
4 tons	....	....	....	....	....	....	1	1
5 tons	....	....	....	....	....	....	2	2

men who preferred the same size as they then owned, and the number preferring larger and smaller sizes, are shown in table 8. There seemed to be a general tendency for the men to think that their trucks were not large enough. Of the farmers reporting, 52 per cent were satisfied with the size they were using, and 43 per cent preferred larger sizes as compared with 5 per cent who preferred smaller trucks.

Of the 251 truck owners who sent complete reports, 32 had owned trucks before buying the ones they then had. The average size of the trucks previously owned was 0.74 ton as compared with 1.26 tons for the size of the trucks owned at the time of reporting. Of these 32 men, 13 reported that they had disposed of their old trucks because they were not large enough. The 1-ton truck had the largest percentage of owners who were satisfied as far as size of truck was concerned, and was preferred by the largest number

TABLE 8. NUMBER OF MEN PREFERRING LARGER OR SMALLER TRUCKS THAN SIZE OWNED

Size of truck owned	Number of each size reported	Size preferred		
		Same size	Larger size	Smaller size
$\frac{1}{2}$ ton	94	28	66	....
$\frac{3}{4}$ ton	22	6	16	....
1 ton	153	107	43	3
$1\frac{1}{4}$ tons	7	3	4	....
$1\frac{1}{2}$ tons	32	12	14	6
2 tons	20	13	4	3
Over 2 tons	17	11	2	4
Total	345	180	149	16

of owners who were not satisfied with the size they then had. Of the 116 men having trucks of less than 1-ton capacity, 82 said they would get a larger size, and 56 specified 1 ton trucks. Of the 119 men who were not using 1-ton trucks and were not satisfied with the size they had, 63 said they would prefer a 1-ton truck, and, in all, 170 out of the 345 truck owners would have bought 1-ton trucks if they were to replace the ones they then owned.

Relation of type of roads to size of trucks used

The men who were doing their driving on all dirt roads, and those who had partly improved roads, were using trucks of about 1 ton capacity (table 9). Truck owners who had all improved roads were using trucks of about $1\frac{1}{4}$ tons capacity. The average size of trucks preferred by the men having all dirt roads was 1.23 tons, and the average size preferred by the men having all improved roads was 1.53 tons. None of these three groups were loading their trucks to full capacity, but the men on the improved roads came the nearest to doing so.

TABLE 9. RELATION OF TYPE OF ROAD TO SIZE OF TRUCK OWNED, AND SIZE PREFERRED, BY 251 TRUCK OWNERS

Type of road*	Number of trucks	Average size of truck owned	Size of truck preferred	Average weight of loads hauled
Unimproved	64	1.04 tons	1.23 tons	0.95 ton
Partly improved	133	1.02 tons	1.27 tons	1.00 ton
Improved	54	1.23 tons	1.53 tons	1.17 tons
Total and average	251	1.07 tons	1.32 tons	1.02 tons

* Macadam, brick, concrete, or asphalt roads considered as improved roads.

MAKES OF TRUCKS USED

There were 60 makes of trucks reported by men who returned questionnaires and those from whom survey records were obtained. The different makes of trucks owned, and the number of each make, reported by the 562 farmers who returned questionnaires are shown in table 10:

TABLE 10. MAKES OF TRUCKS USED ON 562 NEW YORK FARMS

Make	Number of each make	Per cent of total number of all trucks
Ford	353	61.8
Reo	22	3.9
Republic	18	3.2
International	15	2.6
Maxwell	13	2.3
Buick	9	1.6
Samson	9	1.6
Federal	9	1.6
G. M. C.	8	1.4
Dodge	8	1.4
Stewart	6	1.1
White	6	1.1
Ford-Smith	6	1.1
Commerce	6	1.1
Chevrolet	5	0.9
Brockway	5	0.9
Ford-Graham	5	0.9
Overland	5	0.9
Olds	4	0.7
Mack	3	0.5
Selden	3	0.5
Studebaker	3	0.5
Traffic	3	0.5
Vim	3	0.5
Chase	2	0.3
Ford-Dearborn	2	0.3
Ford-Kelly	2	0.3
Nash	2	0.3
Packard	2	0.3
Sanford	2	0.3
Service	2	0.3
Alco	1	0.2
Autocar	1	0.2
Bessemer	1	0.2
Case	1	0.2
Chalmers-Hutford	1	0.2
Day Elder	1	0.2
Dunor	1	0.2
Ford-Babcock	1	0.2
Ford-Traffic	1	0.2
Ford-Truxton	1	0.2
Fulton	1	0.2
Garford	1	0.2
Hewitt	1	0.2
Hudson-Dearborn	1	0.2
Hutford	1	0.2
Indiana	1	0.2

TABLE 10 (*concluded*)

Make	Number of each make	Per cent of total number of all trucks
Jeffrey	1	0.2
Kohler	1	0.2
Monominee	1	0.2
Olsen	1	0.2
Paige	1	0.2
Palmer-Moore	1	0.2
Peerless	1	0.2
Pierce Arrow	1	0.2
Stegman	1	0.2
Sullivan	1	0.2
Velie	1	0.2
Ward La France	1	0.2
Not reported	2	0.3
Total	571	

TIRE EQUIPMENT USED

Information as to the types of tires used on trucks was given on questionnaires by 540 truck owners. The number of trucks of the different sizes which were equipped with solid and pneumatic tires, and the number equipped with pneumatic front and solid rear tires, are shown in table 11. A large proportion of the owners of small trucks were using pneumatic tires, while the solid tires seemed to meet the approval of the men with large trucks better than did the pneumatic tires. Of the trucks of less than $1\frac{1}{2}$ tons capacity 70 per cent had all pneumatic tires, while of the trucks above this size only 15 per cent were so equipped. In all, 60 per cent of the trucks for which this information was obtained had all

TABLE 11. NUMBER OF TRUCK OWNERS USING SOLID AND PNEUMATIC TIRES

Size of trucks	Number of owners using this size	Number using all pneumatic tires	Number using all solid tires	Number using pneumatic front and solid rear tires
$\frac{1}{2}$ ton	142	133	4	5
$\frac{3}{4}$ ton	40	32	6	2
1 ton	238	125	14	99
$1\frac{1}{4}$ tons	13	10	1	2
$1\frac{1}{2}$ tons	48	17	19	12
2 tons	39	7	24	8
Over 2 tons	20	2	17	1
Total	540	326	85	129

pneumatic tires and 16 per cent had all solid tires. The remainder had pneumatic front and solid rear tires.

Some of the advantages of the pneumatic over the solid tires, as given by truck owners, were: less jar and consequently less injury to the load and truck; capability of greater speed; ability to run on softer ground than solid tires can; a special type of wheels not required; lower initial cost; and special labor and equipment for changing not required. Disadvantages of pneumatic tires, as reported by men using them, were: danger of blow-outs and punctures; time and inconvenience of keeping the tires inflated; inability to stand use on rough frozen roads; and wearing quality not so good as that of solid tires.

The number of trucks reported as being equipped with single and dual rear tires is shown in table 12. Of the 528 men who reported whether

TABLE 12. NUMBER OF TRUCK OWNERS USING SINGLE AND DUAL REAR TIRES

Size of trucks	Number of owners reporting	Number using single rear tires	Number using dual rear tires
½ ton	139	139	....
¾ ton	38	38	....
1 ton	236	235	1
1¼ tons	13	13	....
1½ tons	45	45	....
2 tons	38	30	8
Over 2 tons	19	11	8
Total	528	511	17

they were using single or dual rear tires, only 17 were using the dual type. Eight of these were using 2-ton trucks, and eight were using trucks larger than the 2-ton size. One owner of a 1-ton truck reported that he was using dual tires. The advantages of dual rear tires, as given by men using them, were that they would give more traction than single tires and that they were less likely to skid or slide on slippery roads.

It would seem, therefore, that the most satisfactory type of tires for any particular truck would depend on the material to be hauled, the speed desired, the type and probable condition of roads over which hauling would be done, the care which the driver would be likely to give to pneumatic tires, and the relative cost of the two types.

DISTANCE OF TRUCK OWNERS FROM MARKET

Each truck owner was asked how far his farm was from his principal market. The average distance from market of the farmers who furnished this information on their questionnaires is shown in table 13. Approximately one-third of the truck owners were less than five miles from market, one-third from five to ten miles, and the remainder eleven miles or more. The distance of the individual farmers from market varied from one-tenth of a mile to seventy miles, and the average of all reporting was 9.4 miles.

TABLE 13. DISTANCE FROM PRINCIPAL MARKET OF 509 NEW YORK FARM MOTOR-TRUCK OWNERS

Miles from market	Number of owners reporting	Per cent of total number of all trucks	Average miles to market
Under 5	178	35.0	2.8
5 to 10	183	36.0	6.8
11 to 15	51	10.0	13.0
16 to 20	40	7.8	18.4
Over 20	57	11.2	28.7
Total	509	100.0	9.4

About the same proportion of the farmers having small trucks as of those having large trucks were marketing at points nearer and points more distant than ten miles from their farms (table 14). Some of the farmers had changed their principal markets since they began to use trucks. Of the

TABLE 14. NUMBER OF TRUCKS OF EACH SIZE AT DIFFERENT DISTANCES FROM MARKET

Miles from principal market	Size of trucks						
	½ ton	¾ ton	1 ton	1¼ tons	1½ tons	2 tons	Over 2 tons
Under 5	57	12	71	6	15	14	3
5 to 10	42	12	91	4	20	10	4
11 to 15	15	4	23	3	2	3	1
16 to 20	8	6	15	1	5	4	1
Over 20	10	4	26	......	5	3	9
Total	132	38	226	14	47	34	18

411 men who had owned trucks for one year or more, 355 reported as to whether or not they had changed their markets. Of this number, 289 stated that they had not changed their principal markets and 66 stated that they had. These 66 farmers had been marketing their principal products at markets averaging 5.9 miles distant before they began to use trucks, but at the time of reporting they were marketing at points averaging 14.5 miles distant.

The average distance from market of the 103 farms in the dairy section of southern New York from which survey records were obtained was 5.5 miles (table 15), as compared with 9.4 miles for the average of the 509 farmers who reported this information by the questionnaires. The fact that these 103 farmers are marketing their products at points nearer than the average of the 509 men in various parts of the State, is probably accounted for in large part by the fact that their chief sales product is market

TABLE 15. DISTANCE FROM PRINCIPAL MARKET OF 103 FARM MOTOR-TRUCK OWNERS IN BROOME, CHENANGO, AND DELAWARE COUNTIES

Miles from market	Number of owners reporting	Per cent of total number of all trucks	Average miles to market
Under 5	53	51.4	2.9
5 to 10	39	37.9	6.4
11 to 15	7	6.8	13.0
16 to 20	4	3.9	17.0
Over 20	0	0.0	....
Total and average	103	100.0	5.5

milk, a bulky and highly perishable product which must be delivered daily at a railroad shipping point. Whole milk cannot be economically marketed at as great a distance from the point of production as can less bulky or perishable farm products such as grain, fruit, and potatoes, which make up a large proportion of the total production of the average farm in New York.

The introduction of trucks into this region seems to have extended the market milk territory farther back into the hill country. A considerable amount of milk which was formerly hauled by horse and wagon to near-by creameries and cheese factories, is now hauled by truck to a railroad and marketed as whole milk. Results of a survey of the cost of producing milk on 149 farms in this region in 1915 agrees with this observation.[9] The average distance to market of these 149 farms was 4 miles, as compared with 5.5 miles for the 103 dairy farms from which truck survey records were obtained.

SPEED OF TRUCKS

The average speed in miles per hour at which 250 of the trucks for which questionnaires were available were driven, is shown in table 16.

TABLE 16. SPEED OF TRUCKS

Size of trucks	Number of owners reporting	Average speed of trucks in miles per hour	
		Loaded	Empty
½ ton	64	16.3	21.3
¾ ton	14	18.2	21.4
1 ton	116	12.6	15.4
1¼ tons	5	15.4	20.5
1½ tons	24	14.9	17.9
2 tons	18	13.6	15.4
Over 2 tons	9	13.1	14.8
Total and average	250	14.2	17.6

[9] An economic study of dairying on 149 farms in Broome County, New York. By E. G. Misner. Cornell Univ. Agr. Exp. Sta., Bul. 409, p. 400. 1922.

Only 17 per cent of the 116 men having 1-ton trucks were doing the principal part of their driving on improved roads of macadam, brick, or concrete, while 30 per cent of the trucks larger than 1 ton were being driven on roads of these types. This fact probably accounts, at least in part, for the comparatively low speed at which the 1-ton trucks were driven. The relation of type of road to speed of trucks is shown in table 17:

TABLE 17. RELATION OF TYPE OF ROAD TO SPEED OF TRUCKS

Type of road*	Number of owners reporting	Average speed of trucks in miles per hour	
		Loaded	Empty
Unimproved	143	12.8	16.9
Partly improved	286	14.7	18.1
Improved	123	15.3	18.4
Total and average	552	14.3	17.9

* Macadam, brick, concrete, or asphalt roads considered as improved roads.

COSTS OF OPERATING TRUCKS

The average individual costs which make up the total average annual cost of operating the 70 trucks for which complete cost data for one year were obtained, are shown in table 18. The average annual cost of operat-

TABLE 18. AVERAGE ANNUAL COST OF TRUCK OPERATION, EXCLUSIVE OF COST OF DRIVER

(70 trucks in Broome, Chenango, and Delaware Counties)

Number of trucks	70
Average size, in tons	0.91
Average value	$654.10

	Cost per truck	Per cent of total cost
Costs:		
Depreciation	$105.77	26.8
Interest	39.25	9.9
Insurance	0.81	....
License	12.29	3.1
Cash repairs	92.01	23.3
Farm labor, repairing, 31.3 hours	8.15	2.1
Gasoline, 381.7 gallons	105.29	26.7
Motor oil, 24.92 gallons	22.43	5.7
Grease	2.33	....
Use of buildings	6.71	1.7
Total costs	$395.04	

ing a truck, exclusive of cost of driver, was $395.04. Depreciation and fuel were the two largest items of expense, each making up 27 per cent of the total annual cost. Repairs, including value of farm labor used for repair

work, was the next largest item. This amounted to $100.16 per truck. Other costs in order of size were interest, lubrication, license, use of buildings, and insurance.

It can be said that depreciation, fuel, and repairs, each made up approximately one-fourth of the total cost; and interest, lubrication, license, use of buildings, and insurance, together made up the remaining fourth.

Investigations conducted by the Department of Agricultural Economics and Farm Management of the New York State College of Agriculture have shown that the annual cost of maintaining general farm equipment exclusive of trucks, tractors, threshing machines, and some other special equipment, represents about 30 per cent of the average investment.[10] The average value of the trucks included in table 18 was $654.10, and the total annual cost of $395.04 represented 60.4 per cent of this amount. Measured by the percentage of the average investment which the annual cost represents, the cost of operating these trucks, including the cost of gasoline, was double the cost of the general farm equipment as found by cost-account methods. The cost per truck exclusive of gasoline was $289.75, which is 44.3 per cent of the average investment.

Initial cost of trucks

Of the 562 farmers who returned questionnaires, 336 reported that they had purchased their trucks new, 123 that they had purchased second-hand trucks, and 50 that they had built their trucks from automobiles. The remaining 53 did not report on this point. The average initial cost to these men of their trucks is shown in table 19. The cost of the trucks built from automobiles includes the value of the labor spent in building them over.

TABLE 19. AVERAGE INITIAL COST OF TRUCKS PURCHASED NEW, PURCHASED SECOND-HAND, OR BUILT FROM AUTOMOBILES, 509 TRUCKS

Size of trucks	New		Second-hand		Built from automobiles		Total and average	
	Number	Cost	Number	Cost	Number	Cost	Number	Cost
½ ton	50	$ 645.84	51	$ 331.47	27	$340.22	128	$ 456.12
¾ ton	24	1,234.31	8	551.88	5	296.40	37	960.02
1 ton	180	888.77	40	573.88	12	551.67	232	817.04
1¼ tons	10	1,494.10	3	741.67	1	500.00	14	1,261.86
1½ tons	34	1,657.26	9	579.44	2	525.00	45	1,391.38
2 tons	23	2,536.35	8	1,131.25	3	650.00	34	2,039.29
Over 2 tons	15	3,306.67	4	1,525.00	......	....	19	2,931.58
Total and average	336	$1,193.80	123	$543.62	50	$415.76	509	$960.26

Cost of second-hand trucks

The second-hand trucks, which were purchased at an average price of $543.62, cost less than half the average price paid for the trucks bought new, and the average cost of the trucks built over from automobiles was

[10] Cost accounts for six years on some successful New York farms. By G. F. Warren, Van B. Hart, and others. Cornell Univ. Agr. Exp. Sta., Bul. 414, p. 65. 1923.

$415.76. Owners who had used second-hand trucks for an average of 25 months, and owners who had used built-over trucks for 28 months (table 20), estimated that they would get additional satisfactory service of 4.3 years and 4.4 years, respectively, from their trucks. This makes the estimated average years of usefulness to the present owners of the built-over trucks 6.5 years, and of the second-hand trucks 6.4 years.

TABLE 20. AVERAGE INITIAL COST, YEARS OF USEFULNESS TO PRESENT OWNERS AND DAYS LAID UP FOR REPAIRS, OF TRUCKS PURCHASED NEW, PURCHASED SECOND-HAND, OR BUILT FROM AUTOMOBILES

(251 trucks owned one year or more)

How acquired	Number of trucks	Cost	Months owned by present owner	Additional years of service expected	Years of usefulness to present owner	Days per annum laid up for repairs
Bought new	150	$1,209.11	29.5	5.6	8.1	1.9
Bought second-hand	74	570.88	25.0	4.3	6.4	1.3
Built from automobiles	27	373.08	28.0	4.4	6.7	2.2
Total and average	251	$944.68	28.0	5.1	7.4	1.7

Cost of trucks included in survey work

The average initial cost of the 70 trucks located in the dairy section of the southern part of the State is shown in table 21:

TABLE 21. AVERAGE INITIAL COST OF 70 TRUCKS INCLUDED IN SURVEY WORK

Size of trucks	Number of trucks	Average initial cost
½ ton	27	$ 449.63
¾ ton	6	1,187.83
1 ton	24	837.00
1½ tons	10	1,485.00
2 tons	1	1,200.00
2½ tons	2	3,100.00
Total and average	70	$880.00

Depreciation

The largest single item of cost of operating farm trucks, as shown in table 18, was depreciation. The depreciation on these trucks made up 26.8 per cent of the total annual cost of operation, and was 16.2 per cent of the average value of the trucks. Of the 70 trucks included in table 18, 41 had been purchased new by their present owners and 29 had been either bought second-hand or built over from passenger cars.

The average age, at the time of the survey, of the 41 trucks that had been purchased new was 2.22 years. During the first 1.2 years that these trucks were in use, they depreciated from an average value of $1066 to $853. This represents a depreciation of 20 per cent of the original purchase price of the trucks in a period of 1.2 years. During the year following,

the average depreciation was $134.85, or 12.6 per cent of the first cost. The owners of these trucks estimated that their trucks would give an average of 5.2 years of additional service, making the life of the average truck 7.42 years. (Table 40.)

If it is assumed that the average truck lasts 7.42 years, its average annual depreciation would be 13.5 per cent, but the foregoing data agree with the common observation that the depreciation on any kind of farm machinery is much higher for the first few years of use than the average. When these trucks had been in use for a little more than two years, they had depreciated 32.6 per cent of their original cost. The relative depreciation measured in per cent of original cost of trucks of different ages is shown in table 22:

TABLE 22. RELATION OF AGE OF TRUCK TO PERCENTAGE OF INITIAL COST REPRESENTED BY ANNUAL DEPRECIATION

Age of truck at beginning of year	Number of trucks	Average age at beginning of year (months)	Per cent of initial cost represented by depreciation
New	7	0.0	19
1 to 12 months	17	5.1	14
13 to 24 months	9	18.2	9
Over 24 months	8	43.6	8
Total and average	41	14.6	13

The average estimated junk or scrap value of these trucks at the end of 7.42 years was estimated to be $155, or 14.5 per cent of the initial cost. Since the total estimated depreciation for the first four years of use, as shown in table 22, was only 50 per cent of their initial cost, the trucks would have to depreciate 35.5 per cent more during the last 3.42 years of life in order to be worth only $155 as junk. Depreciation on trucks approximately four years old was 8 per cent of the initial cost. Since depreciation usually decreases with age, it would not be expected that these trucks would depreciate 35.5 per cent more during their last three and one-half years of life. This study was made at the end of a period of rapidly rising prices. Truck owners were asked, in estimating depreciation, to disregard any change in price which had occurred since purchasing their trucks, but they were probably influenced by the rapid rise in prices during the preceding year and did not place a low enough value on their trucks. The estimate of length of life of the trucks was independent of the estimate of depreciation, and is likely to be more nearly correct. Estimates on length of life of trucks furnished by 150 truck owners from other parts of the State, agree with these data (table 24).

Depreciation on trucks computed on a fixed percentage basis

When the initial cost, the years of life, and the scrap value of a machine are known, it is possible to compute a rate of depreciation which charges off each year the same percentage of the value at the beginning of the

year.[11] This allows a higher depreciation when the machine is new, and a constantly decreasing amount as it grows older. Depreciation on these trucks for any particular year computed in this way would be 23 per cent of their value at the beginning of that year, or about one-fourth more for the first four years than is shown in table 22.

Not until trucks have been in use longer, can exact depreciation figures be obtained, but the average rates of depreciation as computed by the foregoing method are given in table 23, and these figures are probably very near the actual rates at which farm trucks depreciate.

TABLE 23. ANNUAL DEPRECIATION ON 41 TRUCKS, COMPUTED FROM ESTIMATED USEFULNESS OF 7.42 YEARS, INITIAL COST OF $1066, AND ESTIMATED SCRAP VALUE OF $155

Years used	Value at beginning of year	Depreciation	Value at end of year	Per cent depreciation is of value at beginning of year	Per cent this year's depreciation is of initial cost
0	$1,066.00	$245.18	$820.82	23.0	23.0
1	820.82	188.79	632.03	23.0	17.7
2	632.03	145.37	486.66	23.0	13.6
3	486.66	111.93	374.73	23.0	10.5
4	374.73	86.19	288.54	23.0	8.1
5	288.54	66.36	222.18	23.0	6.2
6	222.18	51.10	171.08	23.0	4.8
7*	171.08	16.08	155.00	....	1.6*
Scrap value	....	....	155.00	....	14.5

* This horizontal column covers only 0.42 year.

Depreciation on trucks compared with depreciation on other farm machinery

The motor truck is a comparatively new addition to the equipment of New York farmers, and experience has shown that depreciation is very high on new kinds or types of farm machines, regardless of whether or not they are given hard usage. Any new type of machine will tend to depreciate because of its becoming obsolete due to the manufacture of improved models which relegate the older machines to the junk pile long before they are worn out. Few of the old wire grain binders were worn out. They were abandoned because better machines took their place. New kinds of machines are also more liable to breakage because of faulty construction than are those which have been tested for many years. A study of tractors on New York farms [12] showed that the average life of the tractors studied

[11] The formula used, which is known as the fixed percentage of the decreasing net value, is

$$R = 1 - \sqrt[n]{\frac{V_2}{V_1}}$$

in which R is the rate per cent of depreciation per year, n is the life in years, V_1 is the initial cost, and V_2 is the scrap value. According to this formula, if the initial cost were $1000 and R were found to be 20 per cent, the value of the truck at the end of the first year would be $1000−$200, or $800. The depreciation for the next year would be 20 per cent of $800, or $160.

[12] An economic study of farm tractors in New York. By W. I. Myers. Cornell Univ Agr. Exp. Sta., Bul. 405, p. 66. 1921.

was 6 years, as compared with 7.42 years for the farm trucks included in table 23. Similar studies of other special farm equipment have shown that depreciation is very high on any new type of machine. The first grain binders and the first tractors were designed and manufactured for farm use and could not be tested in any way except by putting them in practical use on farms. Motor trucks, the manufacture of which was developed by the automobile industry, had been well tested and had passed thru the early part of the experimental stage before they reached the farm.

In making this study the writer did not find, nor has he ever seen, a serviceable motor truck that had been abandoned by a farmer because its place had been taken by a more improved type, but he did see tractors, ensilage cutters, and potato diggers which probably would do almost as good work as when first purchased but which were not used because their place had been taken by more improved machines. Many farmers have sold or turned in their old trucks for new ones; but they did this, not because their trucks were out of date, but because they were wearing out. Had the old trucks been obsolete, no one else would have wanted them and they would have joined the class of the chain-carrier ensilage cutter and the double-driving harness which are found stored away on many farms — still serviceable, but their place taken by something better.

Farmers paid for the testing and development of the grain binder and the gas tractor, but profited by the mistakes others had made in the manufacture of automobiles and motor trucks. Because of this fact one would not expect to find a high depreciation on farm motor trucks due to their becoming obsolete, as has been observed in the past on tractors and other new kinds of complicated farm machinery. The actual depreciation on the trucks included in this study agrees with this observation.

Relation of hauling done with trucks, to length of life of trucks

The extent to which a machine is used generally affects the rate at which it depreciates. The trucks that did less than 600 miles of hauling were estimated by their owners to last 9.5 years, and owners of trucks doing from 600 to 1200 miles of hauling estimated the life of their trucks at 7 years. The trucks doing over 1200 miles of hauling were estimaetd to last 8 years, but they were laid up for repairs almost twice as long as were the 47 trucks that were used for less than 600 miles (table 24).

TABLE 24. RELATION OF MILES OF HAULING TO LENGTH OF LIFE AND TO OTHER FACTORS

(150 trucks bought new and owned for one year or more)

Miles of hauling	Number of trucks	Average miles of hauling	Estimated average length of life (years)	Average days per annum laid up for repairs
Under 600	47	329.0	9.5	1.4
600 to 1200	49	874.8	7.0	1.7
Over 1200	54	2,280.9	8.0	2.6
Total and average	150	1,210.0	8.1	1.9

Repairs

New parts and cash repairs on these trucks cost $92.01 per truck (table 25), and the farm labor spent in repairing them was valued at $8.15 per truck.

TABLE 25. COST OF CASH REPAIRS AND NEW PARTS, 70 TRUCKS

Part repaired or replaced	Number of owners having this expense	Average cost per truck	Per cent of total cash repair cost
Tires	54	$54.47	59.2
Batteries	8	1.25	1.4
Spark plugs	28	1.06	1.2
Radiators	14	2.21	2.4
Gears	11	5.96	6.5
Brakes	28	3.30	3.6
Body	4	0.68	0.7
Unclassified	34	23.08	25.0
Total	....	$92.01	100.0

The cost of tire repairs was the largest single item of repair expense reported, and made up 59.2 per cent of the total cash repair charges. Repairs on gears and on brakes were the two next largest items, making up 6.5 per cent and 3.6 per cent, respectively, of the total cash amount paid for repairs.

Since in most cases home repair work was done by the person driving the truck, such labor was charged for at the same rate as the driver's time. Farm labor on repairs averaged 31.3 hours per truck. The cash cost of repairs and the amount of farm labor spent in repairing varied greatly. Five farmers had no cash expenses for repairs, and the largest amount spent by any truck owner for this item was $400.

The largest amount of farm labor spent on any one truck was 156 hours, and 33 owners did no repair work with farm labor. The five truck owners who had no cash expenses for repairs also had no repairing done by farm labor. Three of the five trucks which had no repairs during the year had been purchased new at the beginning of the year, and one had been purchased new three months prior to that time. The fifth had been bought new by the present owner and had been in use for three years and one month before the beginning of the year. The average depreciation on these five trucks was 18 per cent of their initial cost, as compared with 12.7 per cent for all trucks that were purchased new by their present owners. These five trucks were driven an average of only 2770 miles during the year, as compared with 3589 miles which was the average for the 41 trucks included in table 23. This fact probably accounts, either in part or entirely, for the lack of repairs on these trucks.

Relation of age of truck to days laid up for repairs

There was no very direct relation between the age of the average truck, and its reliability as measured by days laid up for repairs (table 26). The

amount of hauling done with a truck (table 24), and the type of roads over which it is driven (table 59), seem to have more effect on the time it is laid up for repairs than does the factor of age (table 26). While the trucks used the most were estimated to last as long as the others, they were laid up for repairs about a third longer time than was the average truck.

TABLE 26. RELATION OF AGE OF TRUCK TO DAYS LAID UP FOR REPAIRS

(150 trucks purchased new and owned for twelve months or more)

Months owned	Number of trucks	Average number of months owned	Average number of miles of road hauling	Average number of days per annum laid up for repairs	Additional years of service expected	Average number of years of service
12	27	12	1,220.0	1.8	6.75	7.8
13 to 24	53	19.3	1,102.7	1.7	5.3	6.9
25 to 36	32	32.9	1,310.1	0.5	5.1	7.8
37 to 48	21	44.6	1,009.1	5.0	5.0	8.8
49 and over	17	63.8	1,576.5	1.4	5.4	10.7
Total and average	150	29.5	1,208.6	1.9	5.5	8.5

Relation of age of truck to depreciation and repairs

The percentage of the initial cost of the trucks which was represented by the sum of depreciation and repairs, was a smaller figure for the older trucks than for the newer ones (table 27). Depreciation and repairs were 25.8 per cent of the initial cost of the new trucks, and only 17.8 per cent of

TABLE 27. RELATION OF AGE OF TRUCK TO DEPRECIATION AND OTHER FACTORS

	Age, in months, at beginning of year				
	New	0 to 12	13 to 24	Over 24	Total and average
Number of trucks	7	17	9	8	41
Average age, in months	0	5.1	18.2	43.6	14.6
Average size, in tons	0.93	1.06	0.78	0.91	0.95
Per cent of initial cost represented by sum of depreciation and repairs	25.8	23.3	19.1	17.8	21.7
Days per annum laid up for repairs	0	1.2	0.3	4.5	1.4

the first cost of the oldest trucks. However, none of the seven new trucks were laid up for repairs for an entire day when needed, and the trucks owned for more than two years lost 4.5 days per truck due to this cause.

Depreciation on trucks decreases with age and repairs increase, but depreciation is so high for the first years that the sum of depreciation and repairs, when expressed in per cent of initial cost, is a constantly decreasing

figure. If truck owners could insure themselves against loss of time and inconvenience caused by their trucks breaking down, and could get this insurance at just what it costs to carry the risks involved, one might find that depreciation plus repairs plus the cost of this risk insurance was a constant quantity. In other words, the sum of depreciation and repairs decreases with age, but the decrease is probably about offset by the chances that a truck will break down at the time when it is needed the most.

Gasoline

The second largest expense on these trucks was for gasoline, which was practically as important an item as depreciation. The average amount of gasoline used per truck was 381.7 gallons and the average price paid per gallon was 27.6 cents. Gasoline was the only kind of fuel used, and the writer found no farmers who had attempted to use kerosene or distillate in their trucks. These low-grade fuels, which are used extensively in low-speed stationary engines and in tractors, have not proved successful when used for truck motors. The chief objection to them is their tendency to foul up the spark plugs and cylinder heads of the motors with carbon, and the excessive amount of smoke and oil which they give off on combustion.

The average number of miles per gallon of gasoline, and the cost per mile for gasoline, are shown in table 28. For the number of tons which they could carry, the larger trucks were more economical in use of fuel than the smaller ones. The 33 trucks of less than 1 ton capacity averaged 12.4 miles per gallon of gasoline, but, since their average size was only 0.55 ton, they made only 6.8 miles per gallon per ton of carrying capacity; while the 1-ton trucks, and the trucks larger than 1 ton, made 9.5 miles and 13.1 miles per gallon per ton, respectively.

TABLE 28. AVERAGE CONSUMPTION OF GASOLINE BY 70 TRUCKS

Size of trucks	Number of trucks	Average size (tons)	Total miles traveled	Gasoline			
				Gallons	Value	Miles per gallon	Cost per mile
Under 1 ton	33	0.55	3,811	306.7	$ 84.08	12.4	$0.022
1 ton	24	1.00	3,574	375.0	101.64	9.5	0.028
Over 1 ton	13	1.70	4,531	584.4	165.88	7.8	0.037
Total and average	70	0.91	3,863	381.7	$105.29	10.1	$0.027

Relation of age of truck to economy in use of gasoline

The mileage per gallon per ton of capacity was the largest for the new trucks and decreased with age (table 29). The trucks over two years old made only 7.3 miles per gallon per ton, as compared with 9.6 miles for the new trucks.

TABLE 29. RELATION OF AGE OF TRUCK TO ECONOMY IN USE OF GASOLINE AND OIL, 41 TRUCKS

	Age, in months, at beginning of year				
	New	0 to 12	13 to 24	Over 24	Total and average
Number of trucks	7	17	9	8	41
Average age, in months	0	5.1	18.2	43.6	14.6
Average size, in tons	0.93	1.06	0.78	0.91	0.95
Miles per gallon of gasoline	10.3	8.9	10.7	8.0	9.2
Miles per gallon per ton of capacity	9.6	9.4	8.3	7.3	8.7
Miles per quart of oil	29.3	47.5	66.1	24.8	39.5
Miles per quart per ton of capacity	27.2	50.4	51.6	22.6	37.5

Lubrication

These trucks used 24.92 gallons of motor oil per truck, and other lubrication costs amounted to $2.33 per truck. The average price paid for motor oil was 90 cents per gallon. The number of pounds of grease used per truck was not ascertained, as in many cases the only information a farmer could give was that he had paid a garage man a certain amount for filling up his car with grease, and often the charge made was more for the labor involved than for the grease used.

The average number of miles per quart of motor oil for these trucks is shown in table 30. The largest quantity of oil was used by the new trucks and the ones that had been used for over two years, while the trucks that had been owned for from one to twenty-four months used the least oil (table 29).

TABLE 30. AVERAGE CONSUMPTION OF LUBRICANTS BY 70 TRUCKS

Size of trucks	Number of trucks	Average size (tons)	Total miles traveled	Motor oil			Grease (total cost)	Cost of lubrication per mile
				Gallons	Value	Miles per quart		
Under 1 ton	33	0.55	3,811	15.36	$13.00	62.0	$4.06	$0.004
1 ton	24	1.00	3,574	31.11	27.62	28.7	1.35	0.008
Over 1 ton	13	1.70	4,531	37.76	36.75	30.0	5.57	0.009
Total and average	70	0.91	3,863	24.92	$22.43	38.8	$2.33	$0.006

This agrees with the common knowledge that older machines usually require more oil, but will go longer without oiling, than new machines with tight bearing parts. The writer observed that there was a general tendency among owners of new trucks, and especially with men who had had no previous experience with automobile motors, to use an excess of oil

(due probably to the fact that they wanted to be sure to use enough), and that a great deal of oil was lost by leakage from the motors of old trucks. These two facts would tend to give a low mileage per quart of oil for both the new and the very old trucks.

Interest

Interest on the money invested is one of the costs of operating a truck. In figuring the costs of operation, interest was charged at 6 per cent on the average value of the trucks at the beginning and at the end of the year. This item amounted to $39.25, or 9.9 per cent of the total cost of truck operation.

Truck licenses

The average amount paid for a license was $12.29. The laws of New York required, at the time when the survey was taken, that every motor vehicle owned within the State be licensed by the State Commission of Highways, and the charge made for a truck license was in proportion to the maximum load which the truck was licensed to carry. Some trucks were licensed to carry loads in excess of the capacity for which they had been rated by the companies building them, and some others were not licensed to carry loads as large as their rated capacity. In this work, wherever reference is made to a particular size of truck, capacity as rated by the manufacturer, and not licensed capacity, is meant.

Insurance

No liability, collision, or theft insurance was carried on any of the 70 trucks included in the survey work, and only six owners had any special insurance against fire. The cost per truck of fire insurance for the trucks that were insured was $9.42. The average cost of this item for the 70 trucks was 81 cents.

Use of buildings for housing trucks

In determining the total annual cost of truck operation, a charge should be made for the use of the building in which the truck is housed. This charge should cover the costs of maintaining such a building. Results of cost-account investigations show that the average annual cost, in addition to interest, of maintaining farm buildings is approximately 4 per cent of their inventory value. This 4 per cent covers taxes, depreciation, repairs, and other costs of maintenance. In determining the cost of truck operation in this study, a charge of 10 per cent of the value of the buildings used by trucks was made, to cover the interest on such buildings at 6 per cent and the other costs of maintenance. This charge amounted to $6.71 per truck.

Cost of truck driver

Each of the truck owners in the dairy section of southern New York from whom a survey record was obtained, was asked how much he paid per month to the person who drove his truck, or how much it would cost to hire a person equally as good to take the place of the driver in case the owner or another unpaid member of his family was doing the driving. The total number of hours worked per month by the truck driver, and the

value of board or other farm products and privileges furnished to the driver in addition to cash wages, were also ascertained.

The truck owner was asked further what he would have to pay a man equally as good for all other farm work except truck driving. The cost per month and per hour of unpaid and of hired drivers, including the value of board and other farm products and privileges furnished, and the cost to hire men equally as good for all ordinary farm work, are shown in table 31:

TABLE 31. COST OF TRUCK DRIVERS

	Unpaid drivers	Hired drivers	Total and average
Number of trucks	65	5	70
Hours worked per month	247	259	248
Cost to hire for ordinary farm work:*			
Per month	$65.38	$60.60	$65.04
Per hour	$0.265	$0.234	$0.262
Cost to hire for driving:			
Per month	$68.24	$73.60	$68.63
Per hour	$0.276	$0.284	$0.277
Extra cost because of truck:			
Per month	$2.86	$13.00	$3.59
Per hour	$0.011	$0.05	$0.015

* This cost includes value of board and other farm products, and privileges furnished to drivers.

The average cost per month of the unpaid drivers was $68.24, or $2.86 per month more than the cost to hire persons equally as good for ordinary farm work. Hired drivers received $73.60 per month, or $13 more than the cost to hire other farm hands. The cost for all drivers was $68.63 per month, or 27.7 cents per hour. This was $3.59 per month and 1.5 cents per hour above the average figure for which the owners of the trucks estimated they could hire men equally as capable for doing all kinds of farm work except driving. The average cost of driver per truck was $128.98.

TOTAL COST, AND COST PER MILE, OF TRUCKS AND DRIVERS

The various items of cost of operating trucks of different sizes, and the cost of truck drivers, are shown in table 32. The average costs per mile, of trucks and of drivers, are shown in table 34. As would be expected, the cost per mile increased with the size of trucks, but the increase was not in direct proportion.

A better measure of the cost of truck transportation than cost per mile is cost per ton-mile. A ton-mile represents hauling equivalent to moving one ton a distance of one mile. If a truck moves five tons one mile, it accomplishes five ton-miles of work. If it hauls one ton five miles, it also does five ton-miles of work.

Some of the trucks were used to take the place of a passenger car. Of the total miles driven, 11 per cent was for this purpose. The cost per mile of operating a truck was found by dividing the total cost of operation by the total miles driven, including both hauling and passenger use. The cost per ton-mile was found as follows: if 10 per cent of the total mileage of a particular truck was for passenger use and 90 per cent was for actual

TABLE 32. AVERAGE ANNUAL COSTS OF TRUCK OPERATION
(70 trucks in Broome, Chenango, and Delaware Counties)

	Size of trucks						Tota and average
	½ ton	¾ ton	1 ton	1½ tons	2 tons	2½ tons	
Number of trucks	27	6	24	10	1	2	70
Average value	$343.15	$745.83	$643.00	$1,152.50	$850.00	$2,125.00	$654.10
Costs:							
Depreciation	$46.67	$124.99	$118.50	$195.00	$100.00	$250.00	$105.77
Interest	20.59	44.75	38.56	69.15	51.00	127.50	39.25
Insurance	0.00	0.25	0.42	1.50	18.00	6.00	0.81
License	10.21	13.33	10.87	16.88	25.00	25.00	12.29
Cash repairs	76.09	66.56	98.02	97.76	139.00	259.00	92.01
Farm labor repairing*	8.95	3.66	7.72	11.93	0.00	1.20	8.15
Fuel†	78.45	109.41	101.64	85.55	622.83	339.04	105.29
Motor oil†	13.07	12.69	27.63	20.93	129.75	69.38	22.43
Grease	1.81	1.50	1.35	5.90	2.40	5.50	2.33
Use of buildings	6.13	9.42	6.58	7.95	3.50	3.50	6.71
Total cost without driver	$261.97	$386.56	$411.29	$512.55	$1,091.48	$1,086.12	$395.04
Cost of driver	99.87	97.02	128.15	170.87	387.52	340.39	128.98
Total cost of truck and driver	$361.84	$483.58	$539.44	$683.42	$1,469.00	$1,426.51	$524.02

* The average number of hours of farm labor spent in repairing trucks was 31.3.
† The average amounts of fuel and of motor oil used by the different sizes of trucks are shown in tables 28 and 30.

trucking work, then 90 per cent of the total annual cost was considered to be the cost for hauling, and this figure divided by the number of ton-miles gave the cost per ton-mile. The cost per ton-mile for the average of these trucks is shown in table 33, and the cost per ton-mile for trucks of different sizes is shown in table 34.

TABLE 33. AVERAGE COST OF TRUCK OPERATION

Number of trucks	70
Average size, in tons	0.91
Truck cost	$395.04
Cost of driver	$128.98
Total cost of truck and driver	$524.02
Miles driven	3,863
Truck cost per mile	$0.102
Cost of driver per mile	$0.034
Total cost per mile	$0.136
Cost of truck for hauling	$351.64
Cost of driver for hauling	$114.79
Total hauling cost	$466.43
Ton-miles	2,165.6
Truck cost per ton-mile	$0.162
Cost of driver per ton-mile	$0.053
Total cost per ton-mile	$0.215

The average size of load carried by the ½-ton trucks was 671 pounds, and, while it cost only 6.5 cents per mile, exclusive of the cost of the driver, to operate these ½-ton trucks, it cost 30.8 cents per ton-mile of hauling done by them. The cost per mile, exclusive of cost of driver, of the 1-ton

TABLE 34. TRUCK COSTS PER MILE AND PER TON-MILE, 70 TRUCKS

Size of trucks	Number of trucks	Average miles driven	Average ton-miles	Cost per mile			Cost per ton-mile		
				Truck	Driver	Total	Truck	Driver	Total
½ ton	27	4,011	580.4	$0.065	$0.025	$0.090	$0.308	$0.118	$0.426
¾ ton	6	2,910	1,606.2	0.133	0.033	0.166	0.224	0.056	0.280
1 ton	24	3,574	2,425.2	0.115	0.036	0.151	0.159	0.050	0.209
1½ tons	10	3,482	3,168.4	0.147	0.049	0.196	0.160	0.054	0.214
2 tons	1	11,072	11,301.6	0.099	0.034	0.133	0.097	0.034	0.131
2½ tons	2	6,504	12,547.1	0.167	0.052	0.219	0.087	0.027	0.114
Total and average	70	3,863	2,165.6	$0.102	$0.034	$0.136	$0.162	$0.053	$0.215

trucks was 11.5 cents, but their average cost per ton-mile was only 15.9 cents. The average cost per mile, exclusive of cost of driver, for all trucks was 10.2 cents, and the cost per ton-mile was 16.2 cents.

RELATION OF AMOUNT OF HAULING TO COST PER MILE AND PER TON-MILE OF TRUCKS, EXCLUSIVE OF DRIVER

One way to reduce the cost per mile of operating a truck is to drive it more miles; one way to reduce the cost per ton-mile is to do more hauling. Certain of the costs of operating a truck are not affected by the extent to which the truck is driven. Fuel, lubrication, depreciation, and repairs increase with the amount of work done; but interest, insurance, license, and storage are the same whether the truck is driven a thousand miles or ten thousand. For this reason the men who had a small amount of work to do with their trucks had a relatively high cost per mile and per ton-mile.

The relation of the total number of miles that trucks were driven, to the cost per mile of operation and other factors, is shown in table 35. The average cost of operating the 18 trucks that were driven less than 2500 miles was $311.50. The average size of these trucks was 0.82 ton, and it cost 20 cents per mile, exclusive of driver, to operate them. The average sizes of the trucks in the two groups that were driven from 2500 to 5000 miles and over 5000 miles, respectively, were 0.92 ton and 1 ton. These trucks were larger, and it cost more per year to operate them than to operate the smaller trucks; but, since they were driven so many more miles, their costs per mile were relatively low, being 10.8 cents and 7.4

TABLE 35. RELATION OF TOTAL MILES DRIVEN, TO COST PER MILE AND PER TON-MILE EXCLUSIVE OF DRIVER

Miles driven	Number of trucks	Average per truck						
		Total miles driven	Size of truck in tons	Total annual cost*	Cost per mile	Total ton-miles	Hauling cost*	Cost per ton-mile
Under 2500	18	1,557	0.82	$311.50	$0.200	638.7	$294.52	$0.461
2500 to 5000	34	3,565	0.92	385.91	0.108	1,839.5	335.10	0.182
Over 5000	18	6,734	1.00	495.79	0.074	4,308.4	440.01	0.102
Total and average	70	3,863	0.91	$395.04	$0.102	2,165.6	$351.64	$0.162

* For explanation of hauling cost and total annual cost, see page 30.

cents, respectively, as compared with 20 cents for the 18 trucks included in the first group.

The cost per ton-mile of operating the trucks included in table 35 decreased much more rapidly with increased mileage than did their cost per mile. The trucks that were driven the greatest number of miles also did the greatest number of ton-miles of hauling and had the lowest cost per ton-mile. The relative costs per ton-mile of operating trucks of different sizes are shown in table 34, and sorting the trucks into three groups according to the number of ton-miles hauled (table 36) shows again the economy

TABLE 36. RELATION OF TON-MILES OF HAULING TO COST PER TON-MILE, EXCLUSIVE OF DRIVER

Ton-miles	Number of trucks	Average per truck						
		Total ton-miles	Size of truck in tons	Total annual cost	Total hauling cost	Total miles driven	Cost per mile	Cost per ton-mile
Under 800	24	403.6	0.64	$243.18	$177.69	2,535	$0.096	$0.440
800 to 2500	27	1,317.2	0.83	404.44	356.21	4,166	0.097	0.270
Over 2500	19	5,596.7	1.38	573.50	564.88	5,112	0.112	0.101
Total and average	70	2,165.6	0.91	$395.04	$351.64	3,863	$0.102	$0.162

of having enough work for a truck to do. More miles or more ton-miles will usually mean a lower cost for each mile or ton-mile of work done.

EFFECT OF OVERLOADING TRUCKS

The weight of each load hauled was ascertained for each of the trucks included in the survey work. The average weight of load was calculated for each truck, and was found to be less than the rated capacity for 48 trucks and more than the rated capacity for 22 trucks.

The average sizes of loads hauled by these two groups, and their repair costs and costs per ton-mile of truck and driver, are shown in table 37. The overloaded trucks were estimated to last just as long as those that

TABLE 37. RELATION OF OVERLOADING TRUCKS TO COST OF OPERATION AND OTHER FACTORS

(70 trucks in southern New York)

	Average truck loaded above rated capacity	Average truck loaded below rated capacity
Number of trucks	22	48
Average size, in tons	1.1	0.8
Weight of load hauled, in pounds	2,725	1,138
Days per annum laid up for repairs	2.5	0.8
Estimated length of life, in years	8.4	8.25
Cost of repairs	$128.83	$87.03
Total cost of hauling	$431.00	$315.27
Ton-miles of hauling	3,921.6	1,360.7
Truck cost per ton-mile	$0.11	$0.232
Cost of driver per ton-mile	$0.036	$0.075
Total cost per ton-mile	$0.146	$0.307

were not overloaded, but they were laid up for repairs when needed more than three times as long as the trucks hauling the smaller loads. The men who overloaded their trucks had larger repair bills than the other truck owners, but they had larger trucks and did almost three times as much hauling, and their cost per ton-mile of both truck and driver was less than half that of the 48 truck owners who underloaded.

Effect of overloading the Ford 1-ton truck

Of the 20 owners of Ford 1-ton trucks, 7 were overloading and 13 were underloading. The cost of repairs and the total cost of truck operation were larger for the overloaded Ford trucks, but their cost per ton-mile of hauling was only a little over half that of the underloaded trucks (table 38).

TABLE 38. RELATION OF OVERLOADING THE FORD 1-TON TRUCK, TO COST OF OPERATION AND OTHER FACTORS

	Average over-loaded truck	Average under-loaded truck	Total and average
Number of trucks	7	13	[illegible]
Average weight of load, in pounds	2,504	1,250	1,689
Miles driven	3,545	3,446	3,480
Ton-miles	2,958	1,694	2,136
Days per annum laid up for repairs	0.6	0.9	0.8
Estimated length of life, in years	6.5	6.9	6.8
Value of truck at beginning of year	$572	$583	$579
Depreciation	$86.43	$116.46	$106.45
Cost of repairs	$162.29	$98.30	$120 69
Total truck cost exclusive of driver	$413.40	$390.71	$398 65
Hauling cost*	$366.57	$370.55	$369.15
Truck cost per mile, exclusive of driver	$0.117	$0.113	$0.115
Truck cost per ton-mile	$0.124	$0.219	$0.173
Cost of driver per ton-mile	$0.045	$0.065	$0.055
Total cost per ton-mile	$0.169	$0.284	$0.228

* For explanation of hauling cost, see page 30.

These results do not necessarily prove that it pays a farmer to overload his truck, but they do show that, from an economic standpoint, having a large amount of hauling for a truck is of more importance than avoiding overloading. The men who overloaded their trucks had a low cost of hauling per ton-mile, not primarily because they overloaded, but because they had a large amount of hauling to do, and worked their trucks more nearly to full capacity than did the truck owners who underloaded.

COMPARATIVE COSTS OF OPERATING TRUCKS BOUGHT NEW AND TRUCKS BOUGHT SECOND-HAND

Of the 70 trucks in the dairy section of southern New York, 29 were purchased second-hand or built from passenger automobiles and 41 were purchased new. The relation of depreciation and repairs on these trucks to their initial cost and their total annual cost is shown in table 39. The actual amount of the charge for depreciation, repairs, and other items of

TABLE 39. RELATION OF DEPRECIATION AND REPAIRS TO INITIAL COST AND TOTAL ANNUAL COST OF NEW AND OF SECOND-HAND TRUCKS

How acquired	Number of trucks	Per cent depreciation is of initial cost	Per cent repair cost is of initial cost	Per cent depreciation is of annual cost	Per cent repair cost is of annual cost
Bought new	41	12.7	9.1	31.7	22.7
Bought second-hand or built from automobiles	29	10.5	17.0	18.3	29.8
Total and average	70	12.0	11.4	26.8	25.4

expense, together with other factors, is shown in table 40. The total cost of operating the 29 second-hand trucks was $352.57, as compared with $425.08 for the trucks bought new.

TABLE 40. COST, EXCLUSIVE OF DRIVER, OF OPERATING TRUCKS BOUGHT NEW AND TRUCKS BOUGHT SECOND-HAND

	Bought new	Bought second-hand
Number of trucks	41	29
Average size, in tons	0.95	0.87
Present age, in years	2.22	4.75
Initial cost	$1,066.00	$617.41
Value at beginning of year	$853.00	$500.00
Additional years of service	5.2	4.0
Average life of truck	7.42	8.75
Days per annum laid up for repairs	1.4	1.1
Costs:		
Depreciation	$134.85	$ 64.66
Interest	47.16	28.06
Insurance	0.65	1.03
License	12.09	12.57
Cash repairs	90.93	93.54
Farm labor repairing	5.69	11.64
Gasoline	105.52	104.97
Lubrication	21.27	29.67
Use of buildings	6.91	6.43
Total cost	$425.08	$352.57
Per cent depreciation is of initial cost	12.7	10.5*
Per cent depreciation is of annual cost	31.7	18.3
Per cent repair cost is of initial cost	9.1	17.0*
Per cent repair cost is of annual cost	22.7	29.8
Miles traveled	3,589	4,252
Cost per mile, exclusive of driver	$0.118	$0.083

* Initial cost to present owner.

Statements have frequently been made that the high cost of repairs on a second-hand truck will offset the low depreciation on such a truck, and that the sum of depreciation and repairs will be the same on old as on new trucks. The depreciation on the 41 trucks averaging 2.22 years old was

higher than that on the 29 second-hand trucks which had been in use for 4.75 years, but the repairs on the older trucks were only a little more than the repairs on the newer ones. The sum of depreciation and repairs on the 41 trucks bought new was $231.47, and on the average of the second-hand ones was $169.84.

The average cost per truck for gasoline was about the same on the new and the second-hand machines, but the second-hand trucks were driven more miles, making the gasoline cost per mile less. Lubrication costs were considerably higher on the second-hand trucks, but the charge for interest on these was enough lower to more than offset the higher lubrication costs.

The average cost per mile for the second-hand trucks was 8.3 cents, as compared with 11.8 cents for the 41 trucks bought new and having an average age of 2.53 years less than the trucks bought second-hand. The average number of days that the newer trucks were laid up for repairs was 1.4, as compared with 1.1 for the 29 second-hand machines.

These results should not be taken as meaning that it would always pay a farmer better to buy a second-hand truck instead of a new one. The probable service that any machine will give and the price asked for it, together with the work to be done by it, should determine its worth to a prospective buyer. A farm machine which has been used for only one year and has had good care, will usually sell for less than its actual worth as determined by the service it will give.

Due to the high depreciation on new machinery, men who buy new trucks have a high cost of operation for the first year or two of use. In some cases when delays due to a truck breaking down would be very expensive, it might be better to pay this higher cost of operation rather than run the risk of such delays.

TRUCK DRIVERS

Information as to who usually drove the trucks was asked for on the questionnaire used in this study, and a tabulation of the replies of 522 truck owners to this question is shown in table 41. In 335 cases the owner was reported as being the usual driver. About one truck in eight was being operated by a son of the owner, and, in all, 436 trucks were being driven by owners or by owners' sons.

TABLE 41. DRIVERS OF 522 FARM MOTOR TRUCKS

Person driving truck	Number of trucks driven by each class of drivers	Per cent of total number of all trucks
Owner	335	64.2
Owner's son	69	13.2
Owner and son	32	6.1
Owner's daughter	2	0.4
Owner's wife	4	0.8
Owner and other family help	15	2.9
Hired help	36	6.9
Owner and hired help	14	2.7
Others	15	2.9
Total	522	

Very few trucks were being operated by hired labor. Only 36 men reported that their trucks were usually driven by hired labor, and 457 reported that their trucks were being driven by the owner or some member of the owner's family.

The number of owners of the different sizes of trucks, who reported that they were hiring special help aside from regular farm labor, is shown in table 42. Only 1 man with a truck smaller than the 1-ton size was employing special help for driving, while 5 of the owners of 1-ton trucks and 6 of the owners of trucks larger than 1 ton were hiring such help. The average amount per month above the wages of regular farm labor, paid for a driver by men who hired this help, was $13.

TABLE 42. NUMBER OF TRUCK OWNERS HIRING SPECIAL HELP FOR DRIVING

Size of truck	Number of owners reporting	Number hiring special help	Number not hiring special help
Under 1 ton	71	1	70
1 ton	112	5	107
Over 1 ton	51	6	45
Total	234	12	222

The average number of miles which the trucks in the dairy region of southern New York were driven by their owners and by other persons, is shown in table 43. With trucks of less than 1-ton capacity, owners themselves were doing 81 per cent of the driving; with 1-ton trucks, owners were doing 73 per cent of the driving; and with trucks larger than 1 ton, owners were doing 50 per cent of the driving. All of the ½- and ¾-ton trucks were being driven by the owners or by other unpaid family labor, while one-fourth of the driving with trucks larger than 1 ton was done by hired help.

TABLE 43. AVERAGE NUMBER OF MILES DRIVEN BY DIFFERENT DRIVERS (70 trucks, included in table 32)

	Size of truck			Total and average
	Under 1 ton	1 ton	Over 1 ton	
Number of trucks	33	24	13	70
Average size, in tons	0.55	1.00	1.69	0.91
Average number of miles driven	3,811	3,574	4,531	3,863
Miles driven by:				
Owner	3,072	2,608	2,284	2,766
Owner's son	550	765	1,106	727
Owner's daughter	16	....	....	8
Owner's wife	173	....	....	82
Hired help	....	201	1,141	280

Hired help did about the same percentage of the total driving with the trucks in the dairy section, as was done by hired help with the trucks which were scattered thruout the State. Truck owners in the dairy section did about the same amount of driving as the owners of trucks in other sections, and other members of the family did more. This is probably due largely to the fact that family labor does a greater part of the total farm work on a dairy farm than on a general crop and stock farm. Women and boys who may not be able to take a man's place in the field, can frequently make the daily trip to the milk station as quickly and as easily as the farm operator or a highly paid hired man.

There seemed to be a general tendency for more of the driving of the larger trucks to be done by some one other than the owner. Probably this is due principally to the fact that a considerable proportion of these trucks were found on the larger farms, on which there would naturally be more persons available to act as drivers.

Truck owners whom the writer met in this work expressed a variety of opinions concerning the desirability of having truck driving done by hired labor. Some men who had a natural liking for good horses, and on this account probably gave their teams a little better care than the average farmer, felt that their hired help could be trusted with trucks as well as or better than they could with horses. Other farmers — and usually these were younger men, who had had more experience with automobiles and trucks — said that they could trust their help with teams better than with trucks. The relative mechanical ability of truck owners and of the hired men whom they happened to have at the time, probably formed for the most part the basis of these opinions.

To say whether or not it is advisable to have hired labor drive a truck is like saying whether or not hired men are good teamsters. The best teamster on one farm may be the owner of the place, and on the next farm the hired man or the owner's son; and the best truck driver may not always be the man who owns the truck. It requires a certain amount of ability to drive efficiently either a team or a truck.

ROAD HAULING DONE WITH TRUCKS

The average amount of road hauling which 251 truck owners did for their own farms is shown in table 44. On an average, each truck owner handled

TABLE 44. AMOUNT OF ROAD HAULING WITH TRUCKS DONE BY 251 TRUCK OWNERS FOR THEIR OWN FARMS

Size of trucks	Number of trucks	Number of loads per truck	Tons hauled per truck	Miles of hauling per truck	Ton-miles per truck
½ ton	65	219.2	75.6	1,124.9	467.2
¾ ton	14	232.7	184.3	1,334.4	1,085.0
1 ton	116	164.6	147.9	908.7	893.6
1¼ tons	5	135.5	186.9	670.8	1,192.6
1½ tons	24	194.4	332.5	1,406.8	2,283.9
2 tons	18	225.1	545.3	1,346.4	3,273.6
Over 2 tons	9	119.2	510.0	1,495.3	5,722.5
Total and average	251	187.5	191.1	1,083.8	1,276.5

187.5 loads and 191.1 tons of material for his own farm, in addition to doing a small amount of custom work for neighbors.

The kinds of material hauled and the number of tons of each kind are shown in table 45. Crops made up 54.4 per cent of the total material hauled, and the ton-miles of crop hauling represented 57.9 per cent of the total ton-miles. Milk was the second largest item hauled, and made up 24.5 per cent of the total material hauled and 21.6 per cent of the total ton-miles of hauling. The average truck hauled more loads of milk than of crops, but the average load of crops hauled was larger than the average load of milk.

TABLE 45. MATERIALS HAULED ON ROAD WITH TRUCKS, BY 251 TRUCK OWNERS FOR THEIR OWN FARMS

Material hauled	Number of owners reporting this kind of hauling	Amount of hauling per truck			
		Loads	Tons	Miles	Ton-miles
Crops	176	66.0	103.9	469.0	739.7
Milk	80	81.5	46.9	352.3	275.6
Feed	82	10.8	8.5	62.4	61.5
Commercial fertilizer	41	1.6	3.4	8.5	18.1
Lime	20	1.0	1.2	6.6	7.6
Manure	9	3.2	6.8	19.1	55.8
All else	98	23.4	20.4	165.9	118.2
Total	....	187.5	191.1	1,083.8	1,276.5

TRUCK HAULING DONE BETWEEN BARN AND FIELDS

Of the 251 truck owners included in table 44, 73 did some hauling with their trucks between barn and fields. The amount of this kind of hauling done by owners of different sizes of trucks is shown in table 46, and the

TABLE 46. TRUCK HAULING, PER TRUCK, BETWEEN BARN AND FIELDS, 251 TRUCK OWNERS

Size of trucks	Number of trucks	Amount of hauling per truck			
		Loads	Tons hauled	Miles of hauling	Ton-miles
½ ton	65	9.1	3.5	3.4	1.3
¾ ton	14	33.0	24.9	18.5	15.6
1 ton	116	17.8	15.9	5.6	5.1
1¼ tons	5	19.0	19.2	4.8	4.8
1½ tons	24	24.3	28.6	15.7	19.0
2 tons	18	19.4	34.9	14.6	28.6
Over 2 tons	9	6.9	3.3	2.6	1.2
Total and average	251	16.8	15.5	7.3	7.7

materials hauled are shown in table 47. The ton-miles of truck hauling between barn and fields was less than one per cent of the number of ton-miles of hauling done by the trucks on the road.

TABLE 47. MATERIALS HAULED BETWEEN BARN AND FIELDS, 251 TRUCK OWNERS

Material hauled	Amount of hauling per truck			
	Loads	Tons	Miles	Ton-miles
Crops	13.6	12.9	5.3	5.2
Fertilizer	0.4	0.4	0.3	0.3
Manure	0.6	1.0	0.2	0.2
Feed	0.1	0.1	0.1	0.1
All else	2.1	1.1	1.4	1.9
Total	16.8	15.5	7.3	7.7

ROAD HAULING DONE WITH HORSES BY TRUCK OWNERS

Of the 251 truck owners whose questionnaires were included in this study, 244 reported concerning the amount of horse road-hauling which they had done in the past year. Of this number, 128 still did some road hauling with horses, and 116 had done all their road hauling with trucks. The average amount of horse road-hauling for the 244 men who reported this information is shown in table 48. Comparing this table with table 44, it is seen that only 5.3 per cent of the total road hauling reported was done with horses.

TABLE 48. ROAD HAULING DONE WITH HORSES, 244 TRUCK OWNERS

Size of trucks	Number of farms	Number of loads per farm	Total tons hauled	Miles of hauling	Ton-miles per farm
½ ton	62	31.0	33.8	87.7	108.2
¾ ton	14	39.8	19.6	140.9	62.0
1 ton	114	13.7	13.5	50.2	48.8
1¼ tons	5	8.6	15.6	26.5	46.8
1½ tons	24	5.3	7.6	31.9	47.8
2 tons	16	68.0	96.1	93.0	150.4
Over 2 tons	9	8.9	16.4	27.2	47.4
Total and average	244	22.0	24.0	64.6	71.1

The kinds and amounts of the different materials hauled with horses are shown in table 49. Crops represented 44.2 per cent and milk 15 per cent of the total material hauled with horses.

A greater proportion of the milk than of the crops from these farms was hauled with trucks. The number of tons of the various materials hauled

TABLE 49. MATERIALS HAULED ON THE ROAD WITH HORSES, 244 TRUCK OWNERS

Material hauled	Number of owners reporting	Amount of hauling per farm			
		Loads	Tons	Miles	Ton-miles
Crops	51	8.0	10.7	18.7	29.5
Milk	27	7.3	3.6	26.9	14.5
Feed	25	1.2	1.5	5.0	6.2
Fertilizer	11	0.3	0.5	0.6	1.0
Lime	5	0.1	0.3	0.7	1.6
Manure	8	1.5	1.8	2.4	3.8
All else	49	3.6	5.6	10.3	14.5
Total	....	22.0	24.0	64.6	71.1

to and from these farms with trucks and with horses is shown in table 50, and the average weight of loads hauled with trucks and with horses is shown in table 51.

TABLE 50. TONS, PER FARM, OF DIFFERENT MATERIALS HAULED WITH TRUCKS AND WITH HORSES, 251 TRUCK OWNERS*

Material hauled	Total tons per farm	Tons hauled with trucks	Tons hauled with horses
Crops	114.6	103.9	10.7
Milk	50.5	46.9	3.6
Feed	10.0	8.5	1.5
Fertilizer	3.9	3.4	0.5
Lime	1.5	1.2	0.3
Manure	8.6	6.8	1.8
All else	26.0	20.4	5.6
Total	215.1	191.1	24.0

* Hauling between barns and fields not included.

TABLE 51. AVERAGE WEIGHT OF LOADS HAULED ON THE ROAD WITH TRUCKS AND WITH HORSES, 244 TRUCK OWNERS

Material hauled	Weight of load hauled (in pounds)	
	With trucks	With horses
Crops	3,137	2,665
Milk	1,174	989
Feed	1,593	2,596
Fertilizer	4,256	3,581
Lime	2,364	4,310
Manure	4,281	2,472
All else	1,742	3,049
Average	2,052	2,180

CUSTOM TRUCK HAULING

Of the 251 truck owners from various parts of the State included in this study, 89 reported that they did some road hauling with their trucks for other persons, 150 reported no custom truck hauling, and 12 did not report on this point. The average amount received for this work by the farmers who reported this information was $252.04. The average amount of custom hauling per truck is shown in table 52, and the materials hauled are shown in table 53. Custom truck hauling represented only 12.5 per cent of the total road hauling with trucks reported by these 251 farmers.

TABLE 52. CUSTOM HAULING PER TRUCK DONE BY 239 TRUCK OWNERS

Size of trucks	Number of trucks	Amount of custom hauling per truck		
		Tons	Miles	Ton-miles
½ ton	64	0.9	24.8	5.9
¾ ton	12	36.7	315.5	215.5
1 ton	109	19.2	261.3	138.4
1¼ tons	5	1.4	9.9	8.8
1½ tons	23	33.5	214.5	323.4
2 tons	18	42.6	173.0	568.9
Over 2 tons	8	47.3	153.4	972.2
Total and average	239	18.9	180.7	182.2

The average amount received per ton-mile for custom truck hauling was 34.3 cents, as compared with 21.5 cents for the cost per ton-mile of truck and driver as shown in table 33. Much of this custom hauling was done at a time when the truck owners were doing some of their own road hauling. If a farmer is making a daily trip with his truck to a milk station with ten cans of milk from his own dairy, the hauling of ten additional cans for a neighbor would probably not double his cost of truck operation. For

TABLE 53. MATERIALS HAULED AS CUSTOM HAULING, 239 TRUCK OWNERS

Material hauled	Number of owners reporting	Amount of custom hauling per truck			
		Loads	Tons	Miles	Ton-miles
Crops	31	2.3	4.6	27.8	51.5
Milk	13	10.1	6.8	55.8	39.0
Feed	10	1.6	1.9	16.4	23.7
Fertilizer	4	0.1	0.4	1.6	10.4
Lime	3	0.1	0.1	0.5	0.7
Manure	1	0.1	0.1	0.3	0.9
All else	27	3.8	5.0	78.3	56.0
Total	89	18.1	18.9	180.7	182.2

this reason, some farmers were doing truck hauling for less than the actual cost per ton-mile of operating their trucks.

Of 33 truck owners who reported this information, 11 did all of their custom hauling when they were doing hauling for their own farms, and 18 did none of their custom work in this way. The other 4 did a part of their custom hauling when doing hauling for themselves.

TIME REQUIRED FOR ROAD HAULING WITH TRUCKS AND WITH HORSES

Each truck owner from whom a record was obtained was asked to give the amount of time required to do the various kinds of road hauling that he did with his truck, and also the number of horses and the time required to do the same hauling with horse and wagon. A comparison of the actual hours required to do the road hauling on 251 farms, and the hours which these men estimated that it would have taken to do this hauling with horses, is shown in table 54:

TABLE 54. TIME REQUIRED TO DO ROAD HAULING WITH TRUCKS, AND ESTIMATE OF TIME REQUIRED TO DO THE SAME HAULING WITH HORSES

Size of trucks	Number of trucks	Total ton-miles	Hours of horse labor required	Hours of man labor required		
				With trucks	With horses	Per cent hours with trucks are, of hours with horses
½ ton	65	30,366.7	64,054	18,587	40,894	45.5
¾ ton	14	15,190.4	21,507	4,295	10,716	40.1
1 ton	116	103,651.8	153,369	31,587	78,138	40.4
1¼ tons	5	5,963.0	5,318	994	2,659	37.4
1½ tons	24	54,812.7	45,342	8,307	22,496	36.9
2 tons	18	58,924.9	65,452	8,717	32,726	26.6
Over 2 tons	9	51,502.7	32,603	3,062	13,119	23.3
Total	251	320,412.2	387,645	75,549	200,748	37.6

The per cent which the number of hours required to do the road hauling with trucks represented, of the hours which the truck owners estimated would have been required to do the same hauling with horses, varied from 23.3 for the largest trucks to 45.5 for the smallest ones. The 251 truck owners estimated that they were doing their total road hauling in 37.6 per cent of the time that would have been required to do the same hauling with horses.

The number of hours required for hauling the different kinds of materials with trucks and with horses is given in table 55. Crops were hauled with trucks by these farmers in 37.8 per cent of the time required with horses, but feed hauling with trucks required 48.2 per cent of the time required with horses. This can perhaps be accounted for by the fact that, in hauling crops and milk, these farmers were hauling almost the same size of load with trucks as they would have hauled with horses, while, had they hauled their feed with horses, they would have hauled larger

TABLE 55. HOURS REQUIRED FOR HAULING DIFFERENT KINDS OF MATERIALS WITH TRUCKS AND WITH HORSES

Material hauled	Number of owners reporting	Total ton-miles	Average weight of load, in pounds		Hours of horse labor required	Hours of man labor required		
			With trucks	With horses		With trucks	With horses	Per cent hours with trucks are, of hours with horses
Crops	176	185,655.5	3,151	3,138	170,868	31,429	83,063	37.8
Milk	80	69,179.0	1,151	1,159	137,395	27,269	74,773	36.5
Feed	82	15,447.5	1,575	2,000	18,902	4,618	9,575	48.2
Fertilizer	41	4,534.6	4,240	3,698	3,761	649	1,873	34.7
Lime	20	1,917.7	2,364	2,508	3,056	449	1,528	29.4
Manure	9	14,002.0	4,281	3,466	11,948	[illegible],587	5,974	26.6
All else	98	29,675.9	1,741	2,018	41,715	9,548	23,962	39.8
Total and average	......	320,412.2	2,038	2,093	387,645	75,549	200,748	37.6

loads. A common practice among the farm-truck owners interviewed in this study is to haul their purchased feed in small quantities on their return trips from a milk station or a creamery; if they were hauling with horses, they would make a special trip for feed and would haul a larger load. More feed is used by farmers in winter than in summer, and a period of snow and good sleighing, which would tend to increase the size of loads that could be hauled with teams, would decrease the size that could be hauled with trucks. These two facts may account for the less saving of time in hauling feed with trucks as compared with hauling crops and milk.

Size of loads hauled with truck and with horses

The average sizes of loads hauled by owners of the different sizes of trucks, and the sizes of loads they would have hauled if they had used horses, are shown in table 56. There was very little difference in the average size of all loads hauled with trucks and with horses, but the owners of the smaller sizes of trucks were hauling smaller loads than they said

TABLE 56. AMOUNT OF ROAD HAULING WITH TRUCKS DONE BY 251 TRUCK OWNERS, AND HORSE HAULING DISPLACED

Size of trucks	Number of trucks	Tons hauled	Loads		Weight of load, in pounds	
			By truck hauling	By horses	By truck hauling	By horses
½ ton	65	4,913.5	14,246.0	12,008.6	690	818
¾ ton	14	2,580.2	3,258.0	2,818.3	1,584	1,831
1 ton	116	17,155.4	19,091.0	17,902.9	1,839	1,961
1¼ tons	5	934.5	677.5	679.0	2,754	2,753
1½ tons	24	7,980.3	4,665.5	4,962.4	3,421	3,216
2 tons	18	9,814.8	4,052.5	5,368.3	4,844	3,657
Over 2 tons	9	4,590.2	1,073.0	2,104.1	8,556	4,363
Total and average	251	47,968.9	47,063.5	45,843.6	2,038	2,093

they would have hauled with horses, and the owners of the larger trucks were hauling larger loads than they would have hauled with horses. This would indicate that there is a greater range in the sizes of trucks and truck loads than in the sizes of wagon loads.

HORSE AND MAN LABOR DISPLACED BY TRUCKS

Each farmer who furnished information for this study was asked how many more horses and how many more months of man labor he would need if he did not have a truck. The average number of horses and months of man labor which the farmers from different parts of the State who furnished this information said that their trucks displaced, are shown in table 57. The average truck displaced 1.8 horses and 4 months of man labor.

TABLE 57. AVERAGE NUMBER OF HORSES AND MONTHS OF MAN LABOR DISPLACED BY TRUCKS

Size of trucks	Extra horses needed		Additional months of man labor needed	
	Number of truck owners reporting	Average number of horses	Number of truck owners reporting	Average number of months
½ ton	57	1.3	45	2.4
¾ ton	10	2.1	10	4.2
1 ton	111	1.6	90	3.5
1¼ tons	5	2.1	4	6.8
1½ tons	19	2.5	16	5.0
2 tons	16	3.2	17	6.4
Over 2 tons	8	3.7	7	9.9
Total and average	226	1.8	189	4.0

COMPARATIVE COST OF TRUCK AND HORSE HAULING

One of the most frequent questions concerning motor trucks asked by farmers is, "How much does it cost to haul with a truck as compared with hauling with horses?" The costs of operating different sizes of trucks have already been given, in table 32. A comparison of the time required to do the same amount of hauling with trucks and with horses is shown in table 54. In order to compare the cost per mile or per ton-mile of truck and horse hauling, it is necessary to know the cost per hour of horse labor.

Cost-account investigational work indicated that the average cost per hour of horse labor on New York farms in 1921 was approximately 20 cents, and the average cost per horse hour of maintaining farm wagons was 5 cents. Assuming the cost of horse labor on the 70 farms in southern New York which were included in this study, to be 20 cents, and the cost of wagons to be 5 cents per horse hour, figures for the cost of horses and wagons for the hauling which the trucks did can be obtained.

The average number of hours that would have been required to do with horses the hauling done with the 70 trucks, and the cost of this labor

at 25 cents per horse hour (20 cents for horse labor and 5 cents for wagons), are shown in table 58. The cost of drivers for the horses is figured at the same rate as the cost of truck drivers, and the cost per ton-mile of hauling with trucks of different sizes is compared with what it would have cost to do the same hauling with horses.

TABLE 58. COMPARISON OF THE COSTS PER TON-MILE OF TRUCK AND HORSE HAULING

Size of trucks	Costs per ton-mile					
	Truck			Horses and wagons		
	Truck	Driver	Total	Horses and wagons	Driver	Total
½ ton	$0.308	$0.118	$0.426	$0.751	$0.431	$1.182
¾ ton	0.224	0.056	0.280	0.239	0.139	0.378
1 ton	0.159	0.050	0.209	0.228	0.130	0.358
1½ tons	0.160	0.054	0.214	0.222	0.139	0.361
2 tons	0.097	0.034	0.131	0.184	0.068	0.252
2½ tons	0.087	0.027	0.114	0.103	0.067	0.170
Average	$0.162	$0.053	$0.215	$0.257	$0.146	$0.403

The average cost per ton-mile of truck hauling without drivers was 16.2 cents and the cost per ton-mile of horses and wagons without drivers was 25.7 cents; but, since the time required to do the hauling with horses was nearly three times as great, the cost per ton-mile of a driver for horses was 14.6 cents, as compared with 5.3 cents for trucks. It must of course be kept in mind that on farms where horses are required for other work, it would probably be possible to do this additional amount of road hauling at a lower cost per hour than is shown in table 58.

RELIABILITY OF TRUCKS

An important factor to be considered in deciding whether to invest in any machine is its reliability, or the amount of time that it is liable to be laid up for repairs when needed. Inability to use a motor truck is usually due to the truck being out of repair, or to roads being in bad condition because of snow or mud.

Effect of type of roads on length of time trucks could be used

Information concerning the kinds of roads on which each truck was usually driven was obtained, and the truck records were sorted into groups according to whether the trucks were used on unimproved, partly improved, or wholly improved roads. Any type of hard-surfaced road was considered as improved road. The average number of weeks lost on account of snow and mud by the different groups of trucks is shown in table 59.

The average truck owner who did all his driving on unimproved roads lost 8 weeks during the year because of weather conditions; the man who

TABLE 59. EFFECT OF TYPE OF ROADS ON WEEKS LOST BECAUSE OF WEATHER

(251 trucks used for one year or more)

	Type of roads			Total and average
	Unimproved	Partly improved	Improved	
Number of owners reporting	64	133	54	251
Average speed, in miles per hour:				
Loaded	13.1	14.6	14.7	14.2
Empty	17.4	17.7	17.7	17.6
Road hauling per truck:				
Ton-miles	880.5	1,191.8	1,954.6	1,276.5
Hours	279	297	336	301
Horse hauling displaced:				
Man hours	707	758	1,012	800
Horse hours	1,346	1,451	2,010	1,544
Average number of days per annum laid up for repairs	1.8	1.7	2.1	1.8
Average number of weeks lost due to weather conditions	8.0	5.0	3.3	5.4

drove on partly improved roads lost, on the average, only 5 weeks; and the truck driver who had all improved roads lost only 3.3 weeks. The average truck owner lost 5.4 weeks during the year because of bad roads.

Relation of amount of hauling done with trucks to number of days laid up for repairs

Type of road seemed to have little effect on the number of days that trucks were laid up for repairs when needed, but this factor did vary directly with the amount of hauling that was done with the truck (table 60).

TABLE 60. RELATION OF MILES OF HAULING TO LENGTH OF USEFULNESS OF TRUCKS

(150 trucks purchased new and used for one year or more)

Miles of hauling	Number of trucks	Average miles of hauling	Ton-miles	Average length of use	Average days per annum laid up for repairs
Under 600	47	329.0	446.6	9.5	1.4
600 to 1200	49	874.8	1,210.0	7.0	1.7
Over 1200	54	2,280.9	2,958.6	8.0	2.6
Total and average	150	1,210.0	1,600.3	8.1	1.9

There was little relation between the size of the trucks and the number of days they were laid up for repairs. The owners of large and of small trucks suffered about equally in this respect.

Truck parts giving the most trouble

Among the questions asked each truck owner was, what part of his truck had given him the most trouble. The replies to this question are shown in table 61. Tires were reported as giving the most trouble by the largest number of these owners. Different parts of motors were reported as giving the most trouble by 69 men, while 35 stated that their greatest trouble had come from some part of the transmission. Of the specific parts of trucks, timers, transmission bands, spark plugs, and gears were reported most frequently as the most troublesome.

TABLE 61. TRUCK PARTS GIVING THE MOST TROUBLE

Truck part	Number of owners reporting the most trouble with this part*
Tires	54
Motor:	
Radiator	6
Carburetor	1
Batteries	3
Magneto	4
Timer	11
Spark plugs	9
Other ignition trouble	7
Connecting rods and bearings	5
Unclassified	23
Transmission:	
Clutch	4
Transmission bands	10
Drive shaft	2
Gears	9
Differential	2
Drive chains	4
Unclassified	4
Steering gear	2
Brakes	7
Lights	1
Unclassified	4
Total number reporting	172

* Sixty-five reported no trouble, 14 did not report.

ADVANTAGES AND DISADVANTAGES OF MOTOR TRUCKS FOR FARMERS

Advantages

The farmers whose survey records were included in this work were asked what they considered to be the chief advantage of a motor truck for farm business. Many different kinds of replies were given, but the majority of the truck owners seemed to consider that the greatest advantage of the farm motor truck is in its ability to save the time of men and horses.

Some men reported that the advantage of a truck lay in its ability to save time on the road; others stated that a truck enabled them to get to

the milk station or the market early enough to be ahead of the crowd and thus avoid long waits. In all, 52 of the 70 farmers who furnished information on this point reported the chief advantage of a truck as some form of a saving of labor.

The next most important advantage was the saving of horses, which was reported as the most important advantage by 16 of the 70 truck owners. This also was reported in various ways, as, " saves horse flesh," " saves grain and hay," " saves driving horses in warm weather," " keeps horses off from state roads," " saves horses' feet and horseshoeing bills." Other advantages of trucks which were reported were that they made available more distant markets, that they enabled their owners to do custom trucking, and that " the boys like to drive them and so stay on the farm."

Disadvantages

The mechanical difficulties experienced by truck owners have been discussed in connection with tables 25 and 61. Few other disadvantages and difficulties were reported. Of the 70 truck owners from whom survey records were taken, 62 reported no disadvantage, 5 reported bad roads, 2 the cost of upkeep, and 1 the temptation to use the truck for pleasure driving, as the greatest disadvantage of a truck to a farmer.

The lack of good roads is probably one of the most serious highway transportation troubles of New York farmers who own motor trucks, and one of the important reasons why more farmers have not bought trucks. Good roads and farm trucks seem to develop side by side. If a farmer has a good road to town he is more likely to buy a truck than if he has a poor road, and if he is on a poor road and has a truck he is very likely to start out to get the good road.

Relative advantages of trucks and tractors

Of 250 truck owners located in various parts of the State, 89 reported that they owned a tractor. Of these, 37 reported that they considered a truck more essential to their farm business than a tractor. The remainder either considered a tractor more essential, or thought both of equal value (table 62).

TABLE 62. REPORT OF 89 FARMERS OWNING BOTH TRUCKS AND TRACTORS ON THE QUESTION, " IS A TRUCK MORE ESSENTIAL TO YOUR FARM BUSINESS THAN A TRACTOR? "

Size of truck owned	Number of owners having this size	Number reporting truck more essential than tractor
½ ton	15	6
¾ ton	3	2
1 ton	39	12
1¼ tons	4	3
1½ tons	12	6
2 tons	12	6
Over 2 tons	4	2
Total	89	37

While the truck and the tractor are designed for entirely different kinds of work, it is of interest to compare the results of this study of farm trucks with some of the results shown by a similar study of farm tractors.[13]

Since the study of tractors was made in 1920 and the present study of trucks was not started until 1921, a comparison of the costs of operation of tractors and trucks based on these two surveys would be misleading because of the wide fluctuation in prices of fuel, labor, and other items of operation which occurred during the period from 1919 to 1921. However, the efficiency of a day's work by a man and a team, or a month of man labor and a year of horse labor, are things little affected by price changes. The average truck displaced 1.8 horses and 4 months of man labor, and the average tractor displaced 2.4 horses and 4.1 months of man labor. The estimated length of useful life of a tractor was 6 years, and of a farm truck 7.4 years. Depreciation is always high on any new kind of machinery, and the tractor came to the farmer as a new and untried machine while the truck had been well tested in other lines of work before it was introduced to the farmer. The farm was the experimental laboratory for testing the tractor, and the farmer paid for the testing when he purchased useless types of machines.

The average two-plow tractor used 12.8 gallons of kerosene and 4.1 gallons of gasoline per ten-hour day, and the average 1-ton truck used one gallon of gasoline for each 9.5 miles driven.

TRUCK OWNERS OWNING PASSENGER AUTOMOBILES

Of 246 truck owners who furnished this information, 185 owned a passenger automobile in addition to a truck. A larger percentage of the owners of the larger trucks had cars, than of owners of the smaller trucks (table 63). The owners of the smaller trucks used them to take the place of a passenger car more than did the owners of the larger trucks.

TABLE 63. NUMBER OF TRUCK OWNERS WHO OWNED PASSENGER AUTOMOBILES

Size of trucks	Number of owners reporting	Number having an automobile	Number not having an automobile
½ ton	63	31	32
¾ ton	14	13	1
1 ton	115	95	20
1¼ tons	5	2	3
1½ tons	24	20	4
2 tons	17	17	0
Over 2 tons	8	7	1
Total	246	185	61

SHOULD A FARMER BUY A TRUCK?

This study was not undertaken to prove that the average farmer of New York should or should not buy a truck. Its purpose was to make

[13] An economic study of farm tractors in New York. By W. I. Myers. Cornell Univ. Agr. Exp. Sta., Bul. 405. 1921.

available, to farmers of the State, information concerning the costs of operating farm motor trucks and their advantages and disadvantages for farmers' use. Whether or not a farmer is justified in buying a truck depends on the answer to two questions. The first is "Will it pay?" and the second, "Is there any better way to invest money that would be spent for a truck?" In deciding whether or not a truck would be a paying investment, the following points should be considered:

1. Present and probable future amount of hauling to be done.
2. Time and value of man and horse labor that a truck would save.
3. The initial cost and the probable operation cost of a suitable truck, as compared with the cost of hauling with horses.
4. The probable length of time during which snow and mud would prevent use of a truck.
5. The probable development of new and improved highways in the section.
6. The possibility of developing new markets by means of a truck.

If after consideration of these points it would appear that a truck would be a good financial investment for the farm business, then the question whether the money that would be spent in purchasing and operating a truck could be used to better advantage elsewhere should be settled.

CONCLUSIONS AS TO EFFECT OF FARM TRUCKS ON GENERAL WELFARE

The farm motor truck is an important factor in increasing the food supply. The use of motor trucks by farmers has made it possible to profitably produce bulky and perishable products at a greater distance from a railroad than could formerly be done. This is especially true of market milk and of fresh fruits and vegetables. Motor trucks have made it possible also for farmers to reach markets that could not be reached at all by any other means. This bringing of more remote land into intensive use, and widening of the farmer's market, means that more food will reach the consuming public and more feed and fertilizer will reach the farm.

The farm motor truck is a cooperator, not a competitor, of the railroad. Only a small part of the truck hauling done by the farmers included in this study actually replaced railroad freighting, since most of it consisted of hauling between the farm and the railroad. Some hauling was done parallel to a railroad; a part of this was in order to reach a more favorable shipping point; a part of it was hauling products that railroads could not have handled; but the greatest part was hauling products that would not have been produced had it not been for the truck.

A limited amount of the hauling which paralleled the railroads was in direct competition with them. A part of this was done, not because it was cheaper than railroad freight, but because it was thereby possible to get a product to market with only one handling instead of several. Probably the principal reason, however, was that it enabled the farmer to get his product thru to market before it spoiled. There is little doubt that the farm motor truck creates more new freight for the railroads than it takes from them.

The number of trucks on farms has greatly increased during the past five years. How much more it will increase will depend on several factors.

Since the truck is a labor-saving machine, if the wages of farm labor are relatively high there will be a tendency for more farmers to use trucks. Better roads also will mean more trucks. Changes in freight rates on farm products, and changes in the relation between the costs of hauling with trucks and with horses, will affect the number of trucks used. The perfection of an automobile motor which could be operated successfully with kerosene or some other low-grade fuel, or the discovery of new supplies of petroleum, would be a decided factor in increasing the number of motor trucks. Furthermore, any increase or decrease in the demand for the more bulky and perishable food products would create a greater or a less demand for trucks to move such products from the more distant farms to the railroads.

Other factors may have some effect on the extent to which New York farmers will use trucks in the future, but the ones given are probably the most important. Basing an opinion on the present and the probable future relation of these factors, the writer expects to see a large increase during the next few years in the number of farm-owned motor trucks in New York.

UNITED STATES DEPARTMENT OF AGRICULTURE. BUREAU OF CROP ESTIMATES

WITH COOPERATION OF

NEW YORK STATE COLLEGE OF AGRICULTURE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

ITHACA N Y

Oct. 15, 1921.

Dear Sir:

In order to make available to farmers of the State information concerning the costs of operating farm motor trucks and their advantages and disadvantages for farmers' use, we are asking farm truck owners to give us the benefit of their experience.

Will you cooperate by filling out the following blank as completely and carefully as possible and returning it in the enclosed envelope, which requires no postage?

Thanking you for your cooperation, we are

Sincerely yours,

J. B. Shepard
Van B. Hart

INFORMATION ON FARM MOTOR TRUCK

our name ______ P O Address ______

ownship ______ County ______

ow many acres in your farm? ______ What make is your truck? ______

hat is its rated capacity? ______ (Tons) What year was it built? ______ Did you buy it new, second hand, or build out of an auto? ______

ow long have you owned it (or used it as a truck)? ______ (Months) If purchased, what did it cost you, including freight? ______

built on the farm, what did it cost, including auto chassis used, material purchased, and labor of building truck body? ______

ow many more years of satisfactory service do you expect from the truck? ______

ver what kind of roads do you usually drive the truck? (Dirt, macadam, brick, etc.) ______

hat is your average speed on the road when loaded? ______ (Miles per hour) When empty? ______ (Miles per hour).

o you use solid tires on front wheels? ______ On rear wheels? ______ Do you use double tires on rear wheels? ______

ow many weeks during the past year did snow and mud prevent your using the truck? ______

lease give following information concerning the road hauling **to and from your farm** that you did during the past year with your truck:

ROAD HAULING FOR YOUR FARM DONE WITH TRUCK DURING PAST YEAR					HOW SAME HAULING WOULD BE DONE WITH HORSES AND WAGONS			
Material Hauled	Loads per year	Average weight of loads	Miles per round trip	Hours per round trip	Average weight of loads	Miles per round trip	Hours per round trip	Horses per wagon

or what part of the above hauling did you have return loads (loads both ways)? ______

[OVER]

Please give the following information concerning road hauling done during the past year with horses:

Material Hauled	Loads per year	Average weight of loads	Miles per round trip	Reasons for using horses instead of truck for this hauling

Please give below the hauling on the farm between barns and fields done during the past year with truck:

Material hauled	Loads per year	Average weight of loads	Miles per round trip	Reasons for using truck instead of horses for this hauling

HAULING DONE FOR OTHERS DURING PAST YEAR

Material hauled	Loads per year	Average weight of loads	Miles per round trip	Total dollars received	
				$	How much of the hauling done for others was done while doing some of your own hauling?
				$	
				$	
				$	

In the following table, fill in the acres of crops grown and stock kept on your farm.

Crop	Acres	Crop	Acres	Crop	Acres	Stock	Number of head
Alfalfa		Hay		Bearing pears		Work horses and mules	
Barley		Oats		Other bearing orchard		Cows	
Beans		Peas for canning		Truck crops		Young cattle, and bulls	
Buckwheat		Potatoes				Hogs	
Cabbage		Rye		Any other crops		Sheep	
Corn for grain		Wheat				Poultry	
Corn for silage		Bearing apples				Bees	Hives

How many more horses would you need if you did not have the truck?________ How many more months of man labor?________

How far is your farm from your principal market?________ Have you changed your principal market since you got your truck?________

If so, how far was it to your former market?________ If you did not own a truck, would you buy one?________

What size would you get?________(tons). What make?________ Who usually drives your truck?________
(Yourself, son, hiredman, etc.)

Have you had to hire special help for driving the truck?________ If so, how much per month above the wages of regular farm labor do you pay such help?________ What part of the truck has given you the most trouble?________

How many days during the past year was the truck laid up for repairs when you needed it?________ Have you an auto?________

Did you have one before you got a truck?________ Have you a tractor?________ Did you have one before you got a truck?________

Is a truck more essential to your farm business than a tractor?________ How many miles was your truck driven during the past year?________

How many miles of this was for pleasure or passenger use (truck used in place of pleasure car or driving horse)?________

Give the following information concerning any other farm trucks that you have owned:

Make	Size	Cost	Years used	When sold or discarded	Price received	Reasons for selling or discarding

FARM MOTOR TRUCK RECORD

Prepared By

New York State College of Agriculture
Department of Agricultural Economics and Farm Management
Cornell University, Ithaca, N. Y.

Record for year ending__________ 19____ Date__________ 19____ Record Number__________ Tabulation Number__________

Farm Operator__________ P O Address__________ County__________

Distance to principal market__________ miles Has it been changed since getting truck?__________ Miles to former market__________

Have new secondary markets been developed by means of the truck?__________ Distance to these markets__________

Acres owned__________ Acres rented__________ Total acres__________ Value of farm $__________ Value per acre $__________

Make of truck__________ Rated capacity in tons__________ Year built__________

Has truck solid or pneumatic tires in front?__________ On rear?__________ Has it single or dual tires on rear?__________

Was truck bought new, second hand or built on the farm?__________ Months owned or used as truck by present owner__________

Cost if purchased $__________ Cost if built on farm $__________ Value at beginning of year $__________ Value at end of year $__________

Average value $__________ Additional years of satisfactory service expected__________ Estimated junk value when discarded $__________

TRUCK COSTS		
Depreciation	$ X	$
Interest on average value at 6%	X	
Insurance	X	X
Fire		X
Theft		X
Casualty		X
Collision		X
Total	X	
License	X	
Repairs and new parts	X	X
Inner tubes new $ repair $		X
Pneumatic casings new $ repair $		X
Solid tires new $ repair $		X
Batteries		X
Spark plugs		X
Radiator		X
Gears		X
Brakes		X
Body		X
Other cash repairs		X
Total cash repairs		X
Farm labor on repairs hrs at $		X
Total repairs	X	
Fuel	X	X
Gasoline gal at $		X
Kerosene gal at $		X
Total	X	
Lubrication	X	X
Motor oil gal at $		X
Cup grease lbs at $		X
Transmission grease lbs at $		X
Total	X	
Use of building at 10% of $	X	
Garage storage	X	
Other costs	X	
Total cost aside from driver	X	$

TRUCK DRIVER	
Per cent of time driven by owner %, by son %	
by hired help %, by others %	
HIRED DRIVER	
Months hired Hours worked per month	
Total wages paid	$
Value board furnished	
Value of other farm products and privileges	
Insurance on driver	
Driver's license	
Total	$
Cost for ordinary farm work	
Extra cost because of truck	
Cost per month for ordinary work $ per hr.	
Extra cost per hour of truck driver (hrs.)	
Total cost per hour of driver	
UNPAID DRIVER	
Months worked Hours worked per month	
Cost to hire	
Value of board furnished	
Value of other farm products and privileges	
Insurance on driver	
Driver's license	
Total	
Cost for ordinary farm work	
Extra cost because of truck	
Cost per month for ordinary work $ per hr	
Extra cost per hour of truck driver (hrs)	
Total cost per hour of Driver	
SUMMARY	
Total cost of operating truck	$
Total miles traveled during past year	
Truck cost per mile run	$
Cost of driver hrs at $	
Cost of driver per mile run	
Total cost per mile run	
Total ton miles	
Cost per ton mile of truck	$
Cost per ton mile of driver	
Total cost per ton mile	
Average length of haul	miles
Average weight of load	lbs

What is average speed of truck on dirt road when loaded?__________ When empty?__________

On hard surfaced roads when loaded?__________ When empty?__________

Days during the past year truck was laid up for repairs when needed?__________

What part has given the most trouble?__________

Weeks during the past year that snow and mud prevented using the truck?__________

If you did not have a truck would you buy one?__________ What make would you get?__________ What size?__________ Tons capacity__________

Have you an auto?__________ Did you have one before getting a truck?__________ Have you a tractor?__________ Did you have one before getting a truck__________

Is a truck more essential to your farm business than a tractor?__________ Could you handle your present farm business without a truck?__________

How many more horses would you need if you did not have a truck?__________ How many more months of man labor?__________

What do you consider the chief advantages of a truck?__________ The chief disadvantages?__________

ROAD HAULING FOR THIS FARM DONE WITH TRUCK DURING THE PAST YEAR / HOW SAME HAULING WOULD BE DONE WITH HORSES AND WAGONS

Material Hauled	Kind of Roads	Total Loads	Average Weight of Loads	Miles per Round Trip	Hours Driving per Round Trip	Hours Loading and Unloading per Trip	Percent of Time having Return Loads	Total Hours	Ton Miles	Average Weight of Loads	Miles Per Round Trip	Hours Per Round Trip	Horses Per Wagon

TRUCK HAULING ON THIS FARM DONE BETWEEN BARN AND FIELDS DURING THE PAST YEAR / REASONS FOR USING TRUCK INSTEAD OF HORSES FOR THIS HAULING

Material Hauled	Kind of Roads	Total Loads	Average Weight of Loads	Miles Per Round Trip	Hours Driving Per Round Trip	Hours loading and Unloading per Trip	Percent of Time having Return Loads	Total Hours	Ton Miles		Reasons for Using Truck Instead of Horses for This Hauling

CUSTOM HAULING DONE WITH TRUCK DURING THE PAST YEAR

Material Hauled	Kind of Roads	Total Loads	Average Weight of Loads	Miles per Round Trip	Hours Driving Per Round Trip	Hours Loading and Unloading per Trip	Percent of Time having Return Loads	Total Hours	Ton Miles	Total Dollars Received	How much of the custom hauling was done while doing some of your own hauling?

ROAD HAULING FOR THIS FARM DONE WITH HORSES DURING THE PAST YEAR

Material Hauled	Kind of Roads	Total Loads	Average Weight of Loads	Miles per Round Trip	Hours Driving Per Round Trip	Hours Loading and Unloading per Trip	Percent of Time having Return Loads	Total Hours	Ton Miles	Reasons for Using Horses Instead of Truck for This Hauling

CROPS AND STOCK ON THIS FARM

Crop	Acres	Crop	Acres	Crop	Acres	Stock	Number of Head
Alfalfa		Hay		Bearing pears		Work horses and mules	
Barley		Oats		Other bearing orchard		Cows	
Beans		*Peas for canning*		Truck crops		Young cattle and bulls	
Buckwheat		Potatoes				Hogs	
Cabbage		Rye		Any other crops		Sheep	
Corn for grain		Wheat				Poultry	
Corn for silage		Bearing apples				Bees	Hives

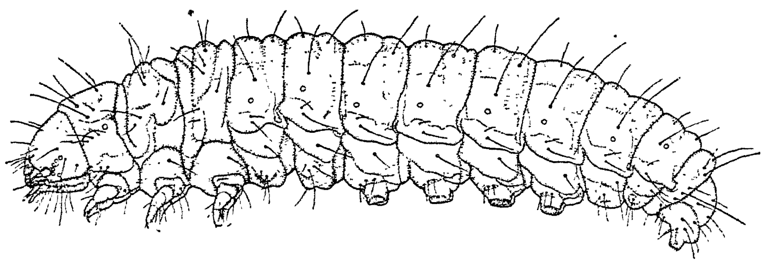
INFORMATION CONCERNING TRUCKS PREVIOUSLY OWNED

Make	Size	Cost	Year Used	When Sold or Discarded	Price Received	Reason for Selling or Discarding

June, 1924 Bulletin 428

The Clover-Seed Caterpillar

Lawrence Paul Wehrle



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CONTENTS

THE CLOVER-SEED CATERPILLAR

(*Laspeyresia interstinctana* Clemens)

Order, *Lepidoptera* Family, *Tortricidae*

LAWRENCE PAUL WEHRLE

Red clover is particularly rich in insect life, especially at the time of blossoming. Folsom (1909) states that there is probably no other plant, with the possible exception of alfalfa, which has such a large number of species or of individuals present at the same time. He says that in Illinois two hundred species were collected on clover, of which more than half feed on the plant. He states further that a hundred more species are predacious or parasitic on the clover insects, or feed on the animal or vegetable matter in the soil.

The entire clover plant is subject to the attack of many species of insects. For example, the roots are injured by the larvae and adults of the clover root-borer (*Hylastinus obscurus* Marsh); the stems are attacked by the clover stem-borer (*Languria mozardi* Latr.), by the clover louse (*Macrosiphum pisi* Kaltb.), and by leaf hoppers (Cicadellidae). Dipterous maggots, larvae of *Oscinis umbrusa* Loew, were found under the leaf sheaths at the crown of the plant by the author. The leaves and the clover head are fed upon by several species of caterpillars, grasshoppers, and beetles. The ovule furnishes food for the larva of the clover-flower midge (*Dasyneura leguminicola* Lint.), and the seed is eaten by the clover-seed chalcid (*Bruchophagus funebris* How.). The clover hay in the stack or in storage is attacked by the clover hay-worm (*Hypsopygia costalis* Fabr.). These forms are in turn attacked by parasitic and predacious enemies, a fact which makes the clover association a very large and interesting one.

The work on which this paper is based was begun in the summer of 1919 and was continued throughout the years 1920, 1921, and 1922, and until the summer of 1923. The present account contains the results obtained from field and laboratory studies of the clover-seed caterpillar (*Laspeyresia interstinctana* Clemens), conducted at Ithaca, New York. Mention is made also of observations recorded in the literature of this species.

CLASSIFICATION AND SYNONYMY

The clover-seed caterpillar (*Laspeyresia interstinctana*) is a small moth belonging to the family Tortricidae or the family Eucosmidae, according to the classification used. Meyrick (1913) divides the group into the family Tortricidae and the family Eucosmidae. On this basis of classification, the clover-seed caterpillar would belong to the latter family. According to another classification, the family Tortricidae, in the broad

AUTHOR'S ACKNOWLEDGMENTS. This work was done under the direction of Professor Glenn W. Herrick, of Cornell University. Acknowledgment is made to Dr. W. T. M. Forbes for aid in classification; to C. F. W. Muesebeck for determination of parasites; and to Miss Ellen Edmonson for criticism of drawings. Acknowledgment is made also for information concerning distribution, which was obtained from Carl Heinrich through Dr. L. O. Howard.

sense, is divided into the subfamilies Tortricinae and Eucosminae. Under this system of classfication, the clover-seed caterpillar would belong to the family Tortricidae and the subfamily Eucosminae. The clover-seed caterpillar has been placed in five different genera and has been known by three different specific names. Clemens (1861) first described the moth under the name *Stigmonota interstinctana*. Then Walker (1863) described it and gave it the name *Dichrorampha scitana*. Grote (1874) next described the species under the name *Grapholitha distema* Grote, and Zeller (1876) described specimens which he received from North America as *Grapholitha* (Ephippiphora) *interstinctana* Clem. Dyar (1902) used the name *Enarmonia* (Hübner) *interstinctana* (Clemens). The last two names were used generally by entomologists until Smith (1910) used the name *Laspeyresia* Hbn. *interstictana* Clem. [*interstinctana* Clem.]. O'Kane (1915), and Barnes and McDunnough (1917), also designated the species under the name *Laspeyresia* (Hbn.) *interstinctana* (Clem.).

COMMON NAMES

Laspeyresia interstinctana Clem. has been known under several common names. It is best known as the *clover-seed caterpillar*, this name having been first used by Professor J. H. Comstock in 1881. Other common names by which this insect has been known are: *clover-seed worm*, a name which was first used by Riley (1893); *clover-head caterpillar*, as the insect was designated by Davis (1894); *clover-leaf caterpillar*, the name used by Gillette (1891); and *seed caterpillar*, the name used by Felt (1915).

HISTORY

The clover-seed caterpillar is without doubt a native of North America, since there are records of its occurrence only in the United States and Canada. Osborn and Sirrine (1894) stated that this insect had been in Iowa for a decade or more. As already mentioned, the adult was first described by Clemens, but that authority does not mention where or under what conditions the first specimen was collected. Grote (1873) described the species as new and gave its habitat as New York and Pennsylvania. Although the adult was first described in 1860, its relation to red clover seems not to have been understood until July, 1874, when Professor J. H. Comstock first noticed the larvae feeding in the heads of clover at Ithaca, New York. The moths and larvae were collected also, by Professor Comstock, on the grounds of the Department of Agriculture at Washington, D. C., in 1879.

DISTRIBUTION

The clover-seed caterpillar is generally distributed throughout the State of New York and the Northeastern and Central States (figure 1). The adult seems to have been first reported from New York and Pennsylvania by Grote (1874). Professor Comstock found the larvae in the heads of clover at Ithaca, New York, in 1874. Zeller (1876) described specimens from Beverly, Massachusetts. Comstock, in 1879, took adults and larvae at Washington, D. C. Fernald (1882–83) records the insect from Maine. Cook (1887), who was the first to report its presence in Michigan, stated that it was fairly common at Lansing in 1885; Davis (1894) also reported

the insect as common in that State. Lintner (1893) records the species from Miami County, Indiana.

Gossard (1892) states that F. M. Webster informed him that he had reared the clover-seed caterpillar from clover heads from Vicksburg,

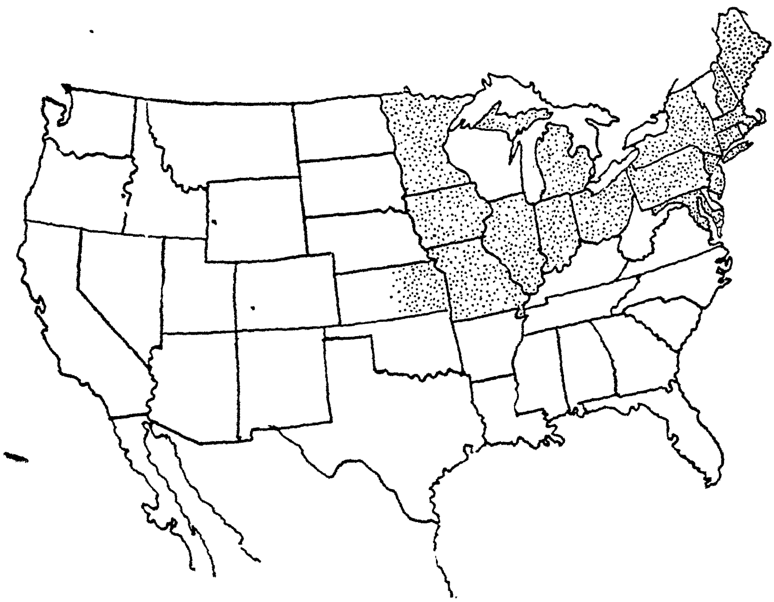

FIGURE 1. GENERAL DISTRIBUTION OF LASPEYRESIA INTERSTINCTANA IN THE UNITED STATES

Michigan, in 1890. Gossard further credits Webster with having observed the insect in Dekalb County, Illinois, fifteen years earlier, and he states also that Webster observed adults abundant at La Fayette, Indiana, in May, 1891, and at Columbus, Ohio, in May, 1892. Gossard says that Gillette observed the clover-seed caterpillar at Ames, Iowa, in October of 1890, and at Champaign, Illinois, in November of the same year. He adds that this insect is probably present in Missouri, since its parasite, *Glypta leucozonata* Ashmead, was reared at Kirkwood by Miss M. E. Murtfeldt in 1887.

Smith (1900) reports the insect in New Jersey from Newark, Anglesea, New Brunswick, and Jamesburg. Fletcher (1906) reports it as present in many places in Ontario, Canada, and Ross (1918) reports it definitely from Vineland and Ridgeway in Ontario.

Gossard (1892) is of the opinion that the clover-seed caterpillar occurs wherever red clover (*Trifolium pratense*) is grown in the Eastern and Central States. Folsom (1909) says that the insect is well established throughout Illinois, holds its own every year, and at intervals becomes locally abundant. Crosby and Leonard (1916 and 1917) report that the species is widely distributed in New York State. There are several specimens of moths from this State in the Cornell University collection. Some

of these moths were taken at Rochester Junction by Leonard, at Trenton Falls by Leonard and Forbes, at Baldwinsville, and at Batavia. The specimens from the two last-named places bear no collector's name. Gossard (1918) mentions the insect as occurring at Wooster, Ohio, and Britton (1920) lists it from Connecticut. In a memorandum received by the author through Dr. L. O. Howard, Mr. Carl Heinrich records the species as present in several localities not previously mentioned in the literature. These new records include Kansas, Minnesota, Manitoba, New Hampshire, and Maryland.

FOOD PLANTS

Common red clover (*Trifolium pratense*) is the chief food plant of the clover-seed caterpillar, although Folsom (1909) states that the insect may occur also on white clover and alsike. The writer has taken the caterpillar on alsike (*Trifolium hybridum* Linn.). Lintner (1896) records that it was reared from white clover (*Trifolium repens*), and he states also that it frequents Helianthus. He says that mammoth clover seems to have been generally considered to be free from attack by the caterpillar, due to the somewhat earlier-maturing qualities of this variety of clover. Folsom (1909), however, found the clover-seed caterpillar on so-called " mammoth clover " which seemed to be a cross between mammoth clover and common red clover. Gossard (1892) states that Webster observed the clover-seed caterpillar in large numbers on *Helianthus grosseserratus* in Dekalb County, Illinois, fifteen years previous to 1892. Gossard reared the clover-seed caterpillar from white clover (*Trifolium repens*), and he also found it on the same plant in the field.

While the writer has no new food plants to record for this insect, he has found that it may pass the winter on or in other plants than clover. Larvae of the second brood have repeatedly been found hibernating within the hollow stems of wheat. The wheat had been sown two years before in the fall, and clover was sown with the wheat the following spring. The cocoon of the clover-seed caterpillar has also been found attached near the base of field, or sheep, sorrel (*Rumex acetosella*).

INJURIES AND LOSSES

The clover-seed caterpillar attracted much attention in some of the Central States during the years 1891 to 1894. It is reported to have been particularly injurious in Iowa, where Osborn (1892) recorded it as being a " quite serious pest " in 1891. Osborn and Gossard (1891 a) estimate a 50-per-cent reduction of the seed crop of clover in Iowa. Gossard (1892) states that Webster informed him that 95 per cent of the clover at Vicksburg, Michigan, was injured. Osborn (1893 c) states that in Iowa the caterpillar caused a considerable loss in the clover crop of 1892, and that, by feeding on the leaves or in the crown of the plant, it caused much injury besides destroying the seed. Osborn (1893 d) also reports that, while the caterpillar was still numerous in Iowa in 1892, it was less abundant than in the previous year. Gossard (1893) reports a loss of more than 50 per cent in some fields of clover in Iowa, and says that the clover-seed caterpillar is the most destructive moth on clover in that State. Osborn and Sirrine (1894) report the caterpillar as having caused more extensive loss throughout Iowa during the year 1893 than had ever before been noticed, and

Osborn (1894 a) states that this insect attracted more attention in 1893 than ever before. He says also that it is of greater importance than the clover-seed midge (*Dasyneura leguminicola*). Davis (1894) reported that the clover-seed caterpillar, while present in Michigan, had not been particularly destructive up to that time, and Fletcher (1905) says that it " has never done very much harm in Canada." Folsom (1909), of Illinois, is of the opinion that the clover-seed caterpillar ranks with the clover-seed midge (*Dasyneura leguminicola* Lint.) and the clover-seed chalcid (*Bruchophagus funebris* How.) as an enemy of clover. He states further that " while not sufficiently abundant to attract attention, the insect is, nevertheless, the unsuspected cause of a considerable reduction in the seed crop; for the destruction of one head by a caterpillar means a loss of more than one hundred seeds."

A study of the behaviour of the clover-seed caterpillar seems to indicate that the insect is constantly present in clover fields, and that at certain intervals it may become locally abundant. Pettit (1914) reports it as having been injurious to June clover, in a restricted area, after it had attracted no particular attention for twenty years; and Gossard (1918) points out that the caterpillar had done no remarkable damage in Ohio for the fourteen years previous to that time.

It is difficult to arrive at any very definite conclusions concerning the full extent of the injury, to the plant or to the seed, caused by the clover-seed caterpillar, since the species is closely associated with other insects injurious to clover and to the seed of clover. The importance of the caterpillar as a factor in the reduction of the seed crop has, however, long been recognized.

The writer attempted to determine the extent to which the heads of clover are infested, and found that the degree of infestation is variable. In 1919 clover heads were collected at different intervals and placed in rearing boxes, and the number of moths which emerged was noted. The contents of the boxes were carefully examined also for dead larvae or pupae, in order that the total infestation might be ascertained. The determination of the percentage of infestation was based on the fact that a single clover head, as a rule, does not have more than one caterpillar infesting it. In

TABLE I. PERCENTAGE OF CLOVER-HEAD INFESTATION IN 1919

Date of collection	Number of clover heads (medium red)	Number of clover heads (alsike)	Total number of clover heads	Total number of *L. interstinctana* specimens	Per cent of infestation
July 2.........	464	216	680	43	6.32
July 17........	768	792	1,560	8	0.51
July 17........	990	1	991	18	1.82
August 8......	133	0	133	7	5.26
August 12.....	211	0	211	12	5.69
August 16......	852	0	852	48	5.63
August 16.....	903	0	903	77	8.53
Average.....	...	...	...	..	4.00

this manner it was found that the infestation in 1919 ranged from 0.51 per cent, the minimum percentage of infestation, to 8.53 per cent, the maximum percentage of infestation (table 1). The average amount of infestation was found to be 4 per cent.

In 1921, heads of medium red clover were collected on different dates and placed in covered glass jars, and later the caterpillars infesting these heads were counted. In this instance again an infested head was considered as having but one insect. The infestation of clover heads in that year varied from 0 to 4 per cent, and the average amount of infestation was found to be 1.59 per cent (table 2).

TABLE 2. PERCENTAGE OF CLOVER-HEAD INFESTATION IN 1921

Date of collection	Number of clover heads collected (medium red)	Number of caterpillars found	Per cent of infestation
July 11.........	100	4	4.00
July 13.........	41	0	0.00
September 23...	100	1	1.00
September 23...	100	2	2.00
September 23...	100	0	0.00
Average......	...	...	1.59

In 1922, heads of medium red clover were carefully dissected, and the number of caterpillars found was recorded. The amount of infestation was found to vary from 0 to 5.8 per cent, the average being 2.07 per cent (table 3).

TABLE 3. PERCENTAGE OF CLOVER-HEAD INFESTATION IN 1922

Date of collection	Number of heads collected (medium red)	Number of caterpillars found	Per cent of infestation
June 26........	86	2	2.3
July 6..........	155	1	0.64
July 17.........	69	4	5.8
October 12......	28	0	0.00
Average......	...	...	2.07

In addition to the reduction of the seed crop, there is a second type of injury, caused by the caterpillars feeding under the leaf sheaths and on the young unopened leaflets at the crown of the plant. This injury is apparently of greater importance than has heretofore been generally recognized. Osborn (1893 c) reports that in Iowa the caterpillar caused much injury to the clover plant by feeding on the leaves at the crown, besides destroying the seed. Folsom (1909) also calls attention to this habit of the caterpillar, and adds that this injury is " done chiefly in September and October."

DESCRIPTIONS OF STAGES

The adult

Clemens (1861) briefly described the moth (figures 2, 3, and 4) of the clover-seed caterpillar as follows:

Palpi whitish. Head and thorax dark brown. Fore wings dark brown, with a curved white, somewhat silvery dorsal streak divided in the middle by a dark brown line and a rather faint silvery streak at the inner angle. The costa from near the base to the tip is streaked with yellowish white, slightly silvery-hued. Hind wings dark brown, along the costa in the middle, white.

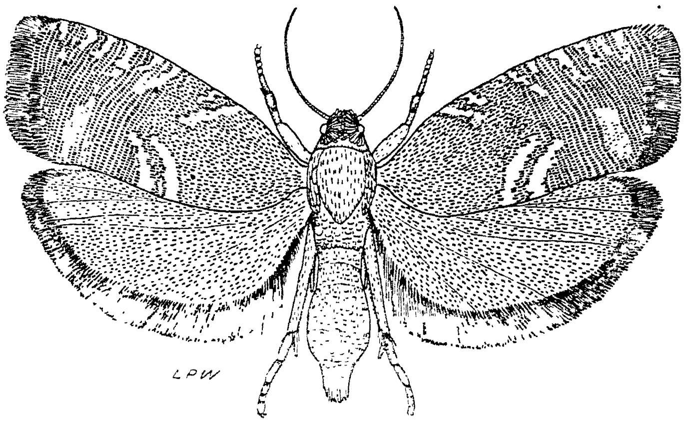

FIGURE 2. ADULT, LASPEYRESIA INTERSTINCTANA, × 9.42

Grote (1874) described the moth more fully as follows:

A tiny blackish silky species resembling the European *compositella*, but with only two white lines on the internal margin of the primaries. Eight white costal marks disposed in pairs, crowded towards the black apices and becoming straighter and shorter; the first pair more oblique and divaricate. A silvery subterminal streak runs from opposite the cell over the median nervules tapering to internal angle. Secondaries fuscous with pale fringes. Beneath iridescent, greenish in certain lights, with minute white costal dots over the outer half of the wing. Body scales beneath whitish.

FIGURE 3. DORSAL VIEW OF ADULT, × 7

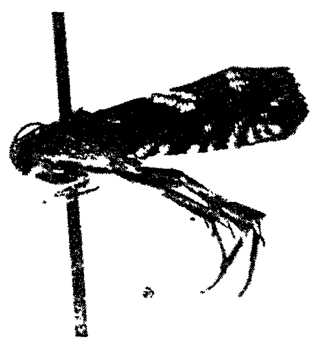

FIGURE 4. LATERAL VIEW OF ADULT, × 7

The egg

Folsom (1909) described the egg (figures 5 and 6) as follows:

The egg, hitherto undescribed, is at first green, then yellowish white, and is almost orbicular as seen from above, tho it is flattened ventrally; the surface is finely granulate and iridescent. The dimensions are as follows: length, 0.275 mm.; width, 0.26 mm.; and height, 0.21 mm.

In slightly more detail, the egg may be described as follows: The shape is elliptical as seen from above, and the surface resting on the leaf is flattened. The egg is at first light green in color, later becoming yellowish green. The shell is faintly granulated and iridescent, reflecting the light at certain angles in reddish, purplish, and greenish hues. The egg is rather small, measuring from 0.513 to 0.540 millimeter long and from 0.297 to 0.405 millimeter wide. It is very much flattened, being only from 0.108 to 0.135 millimeter high. The average size of four eggs, as shown in table 4, was as follows: length, 0.5265 millimeter; width, 0.3712 millimeter, height, 0.1147 millimeter.

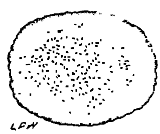

FIGURE 5. DORSAL VIEW OF EGG, × 43.808

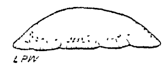

FIGURE 6. LATERAL VIEW OF EGG, × 44.07

TABLE 4. MEASUREMENTS OF EGGS, IN MILLIMETERS

Egg no.	Length	Width	Height
1	0.513	0.297	0.135
2	0.513	0.378	0.108
3	0.540	0.405	0.108
4	0.540	0.405	0.108
Average	0.5265	0.3712	0.1147

The larva

The newly hatched larva.—The newly hatched caterpillar (figure 7) is about 0.81 millimeter long. The head is about 0.189 millimeter wide, and is uniformly dark brown in color; the body is white. The mandibles are reddish brown; the cervical shield is pale gray, nearly white. The caterpillar has four pairs of abdominal prolegs and one pair of anal prolegs. The anal shield is not distinctly visible. The head, the cervical shield, and the body bear numerous rather long white hairs, which are, however, not particularly conspicuous.

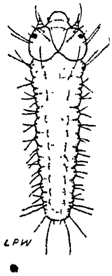

FIGURE 7. DORSAL VIEW OF NEWLY HATCHED LARVA, × 40.306

The full-grown larva.—Comstock (1881) described the larva (figures 8 and 9) as follows:

Length, 8 mm., subcylindrical, tapering slightly at each end; legs and prolegs normal. Color, dirty white, often with a greenish tinge; head, dark brown, trophi, black; prothoracic

shield, yellowish with a brown hind border interrupted in the middle. Body with many delicate whitish hairs. The dorsal piliferous tubercles of each segment arranged in two pairs, of which those of the anterior pair are closer together than those of the posterior pair.

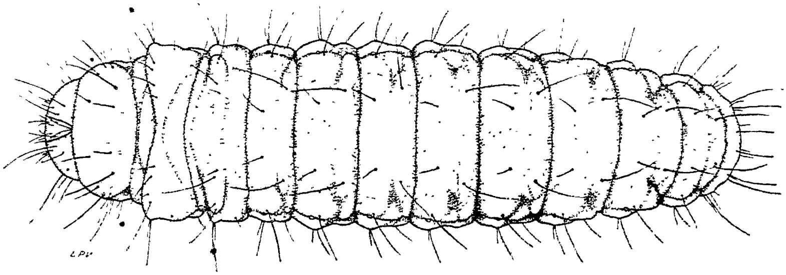

FIGURE 8. DORSAL VIEW OF FULL-GROWN LARVA, × 17.62

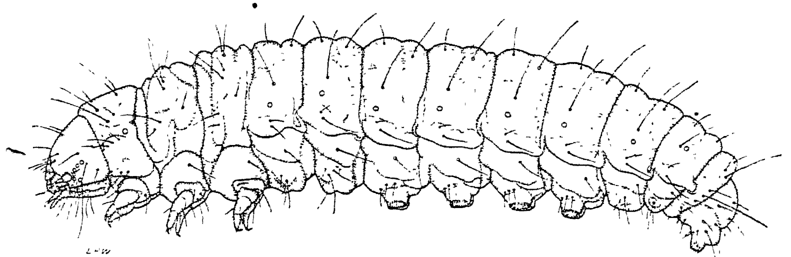

FIGURE 9. LATERAL VIEW OF FULL-GROWN LARVA, × 17.62

The pupa

Comstock (1881) described the pupa (figures 10 and 11) as follows:

Length, 5 mm., moderately slender. Wing sheaths extend to sixth abdominal segment; antennae and posterior tarsal sheaths ending at tip of wing sheaths, the tarsal sheaths being a trifle the longer. Dorsum of each visible abdominal segment except the last with two transverse rows of backward directed teeth, those of the anterior row being strongest. Anal segment blunt at tip, with six stout blackish excurved hooks at its posterior border, two dorsal and four lateral, none ventral; also a number of very delicate hooked filaments. General color rather light-brown, darker on wing covers and dorsum of thorax.

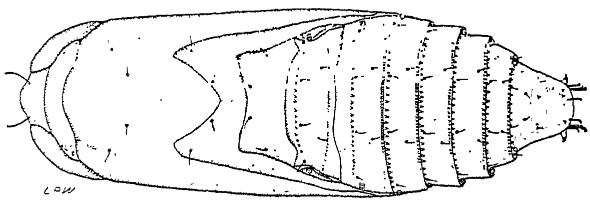

FIGURE 10. DORSAL VIEW OF PUPA, × 18.69

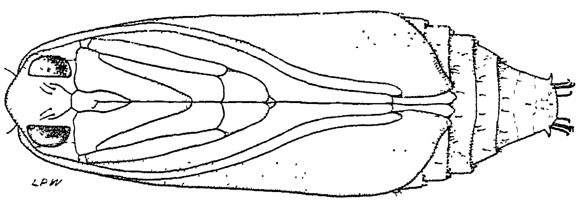

FIGURE 11. VENTRAL VIEW OF PUPA, × 18.69

LIFE HISTORY AND HABITS

The first generation

The adult

Habits.—The moths of the clover-seed caterpillar are most readily seen on still, dark, cloudy days, or on warm evenings at about sunset. At the latter time the moths may be seen taking short irregular flights just above the clover plants. The males appear to be more in evidence at this time, although both sexes are very active. Moths may be found also during the middle of the day. When they are disturbed they fly rapidly, in an irregular or zigzag course. When they alight on a leaflet or any other part of a plant, they may describe a circle by turning around from right to left or from left to right several times, using the head as a pivot, before coming to rest. No explanation for this peculiar habit is evident. Both sexes are numerous in the field.

In mating, the ends of the abdomens of the two moths are brought together, and the valves of the male seem to clasp the end of the abdomen of the female. The heads of the moths are pointed in opposite directions. The process is evidently of several minutes duration.

Time of appearance.—The time of the appearance of the first-generation moths in the field varies with the nature of the season. On June 8, 1920, several moths were collected in the field. By the middle of June this generation seemed to be in full flight. On June 30 these moths were becoming rather scarce in the field. In 1921, a more advanced season, the moths began to appear as early as May 20 and the flight continued until the latter part of June. The moths began to be numerous on June 2 in that year, and were very numerous about June 10. Only one specimen was collected on June 25. In 1922 the moths began to appear about June 1 and continued in flight until the end of June. They were most numerous in the field about June 14.

In the spring of 1920, soil containing bits of clover stems was collected at the base of clover plants and placed in rearing boxes. One box, the soil in which was collected on May 6, yielded two moths, one on May 28 and the other on June 4. This material was subjected to ordinary room conditions; the room temperature may have been slightly higher than that outside. Other similar material collected on June 1 was kept in rearing boxes under outdoor conditions and yielded three moths, one of which emerged between June 6 and June 8, another on June 11, and the third on June 12. On June 9, 1921, a moth emerged from a cocoon collected in the field on November 11, 1920.

Reared specimens emerged during the same time that the moths were in flight in the field. In 1921 a moth emerged on June 20. In 1922 the emergence of fourteen moths ranged from June 8 to June 20 (table 5). In 1923 three moths which were reared from second-generation larvae emerged slightly later than the dates indicated for 1922 (table 13, page 26).

In order to determine the length of life and the number of eggs deposited by moths of the clover-seed caterpillar, reared specimens were studied. A female moth which emerged on June 9 was exposed to males on the same day. The moths were put into a mica cage with a clover leaf, and were fed honey water. The female lived fourteen days and laid 75 eggs. An-

TABLE 5. TIME OF EMERGENCE OF REARED SPECIMENS, FIRST GENERATION, 1922

Date of emergence	Number of emerging specimens		Total emergence
	Males	Females	
June 8	1	...	1
June 9	...	1	1
June 10	1	...	1
June 11	1	...	1
June 12	1	...	1
June 14	1	...	1
June 16	...	1	1
June 17*	...	1	2
June 20	2	3	5

* One specimen, sex not determined.

other female moth, which emerged on June 20, was exposed to males on June 21. The experiment was conducted in the same manner as the preceding one. This female lived eleven days and laid 31 eggs.

The egg

Place and manner of deposition.—The small, flattened, greenish eggs of the clover-seed caterpillar may be laid on almost any part of the plant above the ground. The eggs of the first generation of moths kept in cages are deposited singly, as a rule, but occasionally they are deposited in groups of two or three on the upper and lower surfaces of the leaves, on the stems, and on the stipules at the bases of the developing heads. The first-generation moths have a tendency to oviposit more freely on the lower surface of the leaf than on the upper surface. For example, in 1920, in two experiments with clover plants, it was found that of a total of 114 eggs deposited by the moths, 66 eggs were laid on the lower side of the leaf and 47 eggs were laid on the upper side; and only one egg was found on the leaf petiole. The plants used in these experiments had no heads. In 1921 the same general tendency in egg deposition was noted when leaves of clover were inclosed in mica lamp-chimney cages and exposed to moths. Of a total of 87 eggs, 60 were deposited on the lower side of the leaves, 25 on the upper side, and 2 on a stipule at the base of a developing head. No eggs were found on the petioles or the stem. In 1922 eggs which appeared to be those of the clover-seed caterpillar were found in the field. These eggs had been deposited singly on the under side of the leaf. Fletcher (1905) states that the eggs of the clover-seed caterpillar are laid on peas as well as on clover.

Time of deposition.—Moths of the first generation deposit their eggs on clover in early summer. The time of deposition corresponds to the flight of the moths, which has already been discussed. In 1920 moths deposited eggs under cage conditions on June 27, June 29, July 2, and July 3. In 1921 moths deposited eggs under cage conditions on June 3, 4, 7, and 9, and in 1922 on June 16 and 17. Eggs that appeared to be those of *L. interstinctana* were found in the field on June 15, 1922.

Incubation period.—The length of the egg stage varies somewhat, apparently depending upon temperature. In 1920 it was found that 43 eggs deposited by the first-generation moths hatched in eight days. In 1921,

7 first-generation eggs hatched in eight days and 49 first-generation eggs hatched in nine days. One egg hatched in ten days. In 1922, 23 eggs deposited by moths of the first generation hatched in ten days, and 5 first-generation eggs hatched in eleven days. These results indicate that the length of the egg period of the clover-seed caterpillar is from eight to eleven days, the average being about nine days. The records given in table 6 represent a few typical examples selected from many observations.

TABLE 6. LENGTH OF EGG STAGE OF FIRST GENERATION

Year	Experiment no.	Leaf no.	Leaflet no.	Date when eggs were deposited	Number of eggs	Date when larval head appeared*	Date when eggs hatched	Length of egg stage (days)
1920......	100.4	1	2	July 1	6	July 8	July 9	8
	100.5	1	1	2	2	9	10	8
	100.5	2	1	2	3	9	10	8
	100.6	1	3	3	2	10	11	8
	100.6	3	1	3	1	10	11	8
1921......	2	1	1	June 3	6	June 11	June 12	9
	2	2	1	3	9	11	12	9
	2	2	2	3	6	11	12	9
	2	2	3	3	17	11	12	9
	3	1	2	4	1	13	13	9
	2	2	1	3	1	....	13	10
	5	1	1	7	7	June 14	15	8
1922......	12	1	1	17	2	26	27	10
	12	1	2	17	15	26	(12) June 27	10
							(3) June 28	11
	12	1	3	17	11	26	(9) June 27	10
							(2) June 28	11

*These dates apply to the majority of the eggs listed.

Developments.—The first external evidence of the developing larva within the egg is the appearance of two very small, reddish brown spots near one end of the egg. These spots have the appearance of tiny eyes, and can be distinguished by the aid of a hand lens. It is in this region of the egg that later the dark brown head of the young caterpillar can be distinguished. The eye-like spots can be seen about two days before the egg hatches, and in most cases the head of the caterpillar is plainly visible within the shell, or chorion, the day before hatching.

Hatching.—In hatching, the larva makes a hole in the upper surface of the egg shell, usually near one end, and forces its way through this small opening. Sometimes the larva may escape through a similar opening nearer the middle of the egg. The process of hatching lasts only about a minute, and the larva, by wriggling about from one side to the other, succeeds in freeing itself of the egg shell. The active larva emerges from the egg head first and immediately leaves the shell, apparently in search of a suitable place to feed. There is no tendency for the larva to eat the egg shell. The newly hatched caterpillars may feed on the tender young leaflets that have not yet unfolded at the crown of the plant.

It was noted that some of the eggs in the experiments did not hatch, but turned brown or yellow. It was noted also that the larva may die within the egg, even when development has been nearly completed.

The larva

Habits.—The young larvae, on hatching, may crawl down the stem or the petiole to the crown of the plant. Here they feed on the tender young leaflets that have not yet unfolded, eating irregular holes into them. The larger caterpillars may make their way under the leaf sheaths at the crown of the plant, where they feed on the tender tissues, sometimes making round holes to the outside. This may cause the death of the leaf and its petiole. The larvae also injure both the young green heads and the more developed heads of the clover.

In green clover heads the external evidence of the presence of the caterpillar is a more or less continuous brown area, which may extend across or along one side of the clover head. This area is composed of dark brown particles of dry excrement, and hairs taken from among the florets and tied together with silk. When the infested head is pulled apart, one finds a burrow eaten through the forets, and it is within this cavity that the yellowish caterpillar is found. The caterpillar eats off the florets near their bases, and thus destroys many of the developing seeds while making its way through the head. The inside of the burrow is brown, due to the injured florets which are dying and turning brown. Within the burrow, dark brown particles of excrement may be found. The burrow may extend through the enclosing stipules at the base of the clover head, to the outside.

The more developed blossoming heads of clover are injured in much the same manner as is described for the green heads. The caterpillar, in feeding on the florets, forms a burrow in the head. The florets along the course of the burrow are eaten off, either entirely or only in part. Many of the florets along the sides of the burrow have holes eaten into them, and are thus destroyed. The florets are fastened together with silk over the burrow, within which bits of brown excrement may be found

The caterpillars do not feed on clover heads after the seeds have become mature and the calyces have become dry and brown. An infested head of clover usually contains but one caterpillar under field conditions; in rearing cages, however, as many as four second-generation caterpillars have been observed feeding within a single head. Clover-seed caterpillars are active, and will wriggle out of their burrows in infested heads or will come out from under leaf sheaths or from within their cocoons, if they are disturbed.

It was noted in 1920 that under cage conditions the caterpillars may burrow down into the hard, woody part of the plant at the crown. In 1922 the habit of burrowing within the stem was again noticed in reared specimens.

Time of appearance.—In cage studies in 1920, the first generation of larvae appeared in early July and continued active until early August. These caterpillars had spun their last cocoons by August 9. This somewhat late appearance of first-generation larvae in rearing cages is due to the fact that the moths from which the eggs were obtained were collected during the last few days of the flight of the first generation of moths in the feld.

In 1921, the larvae were numerous in the field on July 11, at the crowns of the plant under the leaf sheaths, and in the heads. Many of the caterpillars were full-grown at that time. In rearing cages, the caterpillars began to hatch from the egg on June 12, and the last of these larvae appeared on June 17. A larva which hatched on June 12 became full-grown and spun its final cocoon between July 2 and July 6, and pupated on July 7.

In 1922, first-generation caterpillars were found in the field on July 14. Full-grown larvae were found on July 19 under the leaf sheaths at the crown of the plant. Larvae reared from eggs which hatched from June 28 to July 4 molted for the last time from July 12 to July 21 (table 13, page 26).

The generations of the clover-seed caterpillar are sharply demarcated, the larvae being very scarce when the moths are in flight. The time of the appearance of the first-generation moths and larvae coincides with the growth of the first crop of clover. The larvae, on becoming full-grown, spin silken coverings over themselves where they have been feeding, and later transform to pupae within these cocoons.

The cocoon.—The first-generation caterpillar spins its final cocoon a few days before pupation. The cocoon is often formed in the burrow where the larva has been feeding, although the larva may migrate to another part of the plant and spin its cocoon. The larva may even leave the plant on which it has been feeding, and spin its cocoon elsewhere. Cocoons of the first-generation larvae reared in cages were found in the following situations: on the ground; partly in the ground; in dead stems of clover and other plants; at the side of the crown of the clover plant; among folded dry leaflets of clover; in the heads. In the field, cocoons are found most commonly under the leaf sheath at the crown of the plant and in the clover heads. When the larva is protected within two leaf sheaths at the crown of the plant, it does not use nearly as much silk in making its cocoon, because the leaf sheaths evidently serve in part as a covering.

In 1921 a reared caterpillar spun its cocoon between July 2 and July 6. In 1922 larvae that hatched in late June and early July spun their cocoons from July 22 to August 14.

The larva, in the course of its development, molts a number of times. Shortly before molting, it may and often does spin around itself a thin silken covering, or molting cocoon, as it rests in the folds of tender young leaflets. After the larva has molted, the cast head-cap may be found in the molting cocoon. The cast larval skin is rarely seen except after pupation, when it is found attached to the last head-cap in the final cocoon.

The process of spinning the silk was observed to be as follows: The silk thread is spun from near the end of the labium. In order to get the silk into place, the caterpillar uses a shuttle-like movement of the head, weaving the silk from one leaflet edge to another. It first spins a few connecting or foundation threads between the edges of the leaflets, and then goes back and fills in these threads with a network of other silk threads. It then moves forward again and repeats the process. The writer was not able to observe the process of weaving the silken covering surrounding the larva within the folded leaflet. An examination of such a silken covering, however, indicates that it is made in the same manner.

After the last molt, and a few days before pupation, the larva spins a final covering or cocoon, within which it continues its development. The shape of the cocoon is somewhat dependent upon the situation in which it is formed. It may be oval, and the color is grayish or brown. It is about $5\frac{1}{2}$ millimeters long and $1\frac{1}{2}$ millimeters wide. It is made of thin, closely woven silk, and numerous bits of plant tissue and excrement are usually attached. Some cocoons are more strongly made, having a greater amount of plant tissue or other supporting material attached, and being from 6 to 8 millimeters long and about $2\frac{1}{2}$ to 3 millimeters wide. The cavity of this cocoon is lined with white silk and is smooth.

Length of larval period.—The length of the larval stage of the first generation was found to vary somewhat. In 1920 it was approximately 29 days (table 7). In 1921 the larval period of one specimen was 25 days. In 1922 the length of the larval stage was found to be about 31 days.

TABLE 7. LENGTH OF LARVAL STAGE OF FIRST GENERATION

Year	Specimen no.	Date when egg hatched	Date of pupation	Length of larval stage (days)
1920	100.b	July 2–6	August 10	35–39
	100.4	July 9	August 6	28
	100.7	July 11–13	July 31	18–20
	100.7a	July 11–13	August 12	30–32
1921	1Ab	June 12	July 7	25
1922	1	June 28	August 2	35
	4	June 29	July 29	30
	6	June 29	July 25	26
	11	July 2	August 6	35
	12	July 2	August 15	44
	18	July 4	August 5	32
	20	July 4	July 30	26
	XV-2	June 27	July 20–22	23–25

The pupa

The larva pupates within a silken cocoon, the location of which has been already described. The time of pupation is comparatively constant. In 1920, collected caterpillars and reared caterpillars pupated in late July and early August. In 1921 a reared specimen pupated on July 7. In 1922 a pupa was found in the field on August 4, and reared specimens pupated from the latter part of July until the middle of August (table 8).

The pupal period varies within rather narrow limits. In 1920, moths emerged from eleven to sixteen days after pupation (table 8); the average length of the pupal period was about fourteen days. In 1921 the pupal period of one specimen was ten days. In 1922, moths emerged from ten to fifteen days after pupation; the average length of the pupal stage was about thirteen days.

TABLE 8. LENGTH OF PUPAL STAGE OF FIRST GENERATION

Year	Specimen no.	Date of pupation	Date of emergence	Length of pupal stage (days)
1920	3	August 4	August 15	11
	16	July 27	August 12	16
	25	July 31	August 14	14
	100.4	August 6	August 18	12
	100.7a	August 12	August 27	15
1921	1Ab	July 7	July 17	10
1922	1	August 2	August 17	15
	4	July 29	August 11	13
	6	July 25	August 7	13
	11	August 6	August 18	12
	12	August 15	August 25	10
	18	August 5	August 18	13
	20	July 30	August 13	14

The second generation

The adult

Emergence.—The pupa of the clover-seed caterpillar is active. This activity becomes more pronounced just before the emergence of the adult, when the pupa escapes through one end of the enveloping cocoon. After the adult has emerged, the pupal case often remains attached to the cocoon by its caudal end. The following behavior was noted during the emergence of an adult: The pupa, which lay on a glass slide after it had escaped from its cocoon, was active, and this activity gradually increased, the pupa rolling over and over due to the movements of its abdomen. Soon the moth was seen forcing its way out at the anterior end of the pupal case by a turning motion of the abdomen. This process was completed very quickly, the actual emergence taking about half a minute. As soon as the moth was out, it crawled away from its pupal case and kept twisting its abdomen around and around in screw-like fashion. Its wings, which were somewhat sac-shaped, hung limp. At this time, and again a little later, a pale cream-colored liquid was voided. From five to ten minutes after emergence, the moth raised its wings, apparently to dry, unfold, and spread them. The twisting motion of the abdomen was not so marked at this time. During the next three minutes, or by the thirteenth minute after emergence, the moth gradually let its wings down until they were in the normal position. It made its firs attempt at flight within the next three minutes, or by the sixteenth minute after emergence.

Time of appearance.—The moths of the second generation appear in the field at a nearly uniform time each year. In 1919 they were seen on August 3, were numerous on August 5 and 8, and were still present in the field on September 5 but were getting scarce; one moth was taken as late as October 8. In 1920 the time of appearance of the moths corresponded very closely with that in 1919; the moths appeared first about August 4, were numerous on August 18, and had practically disappeared by September 3. In 1921 the appearance of the moths was somewhat earlier; a few were

found on July 18, and the number was considerably increased by July 28; the moths were frequently seen in the field from August 5 to August 23; the flight seemed to be over by September 1, although one female moth was taken as late as September 8. In 1922 no moths of the second generation were observed in the field before July 19; on July 26 they were present in considerable numbers, and on August 3 they were very numerous; by August 16 they were becoming scarce, and by September 1 no moths were found in the field.

In 1919 first-crop clover heads were collected in the field and the time of emergence of the moths was noted. From heads collected on July 2, adults emerged from July 19 to August 4. The greatest number appeared between July 24 and July 29. Heads collected on July 17 yielded moths from July 19 to August 20. The greatest emergence of these occurred between August 7 and August 12. Second-crop clover heads and stems collected as late as August 12 yielded one adult on September 6, while those collected on August 16 gave a moth on September 7 and continued to yield moths until as late as October 4. These dates show a slightly earlier emergence of moths in rearing boxes than in the field.

In 1920, six moths were successfully reared from the egg, and thirty-three were reared from larvae collected on plants in the field. A striking parallelism was noted between the dates of emergence of these moths, and the dates of the appearance of moths in the field. Reared specimens began to emerge between August 5 and August 9, as compared with August 4, the date when the moths were first seen in the field. Of the total of thirty-nine reared specimens, twenty-seven emerged between August 10 and August 19, while on August 18 the moths were numerous in the field. The flight in the field ended about September 3, the date on which the last of the reared specimens emerged.

In 1921 five moths were reared from the egg. The first reared specimen emerged on July 16; the approximate date for the first appearance of moths in the field was July 18. The last of the reared specimens emerged on July 26.

In 1922 seven moths were reared from the egg, and their emergence ranged from August 7 to August 25 (table 13, page 26). This corresponds to the flight of moths in the field, which ranged from late July until late August.

The egg

Place and manner of deposition.—The eggs of the second-generation moths are deposited in the same manner and position as are the eggs of the first generation. The second-generation moths also showed the same tendency to deposit the greater proportion of their eggs on the lower surface of the leaves as was shown by the first generation. In 1920, in two experiments, clover plants were exposed to moths. Of a total of 63 eggs, 44 were deposited on the lower surface of the leaves and 16 were deposited on the upper surface, while only 3 eggs were found on the stems. The plants had no heads. In 1921, clover leaves and a blossoming head were put into a mica lamp-chimney cage and exposed to moths. Of the 26 eggs deposited, 9 were placed on the upper surface of the leaves, 9 on the lower surface, and 8 on the head. The eggs on the head were fastened to the side of the corolla, and only one egg was deposited on a floret.

Time of deposition.—The time of egg deposition corresponds to the time of the appearance of the moths in the field and has already been discussed. In 1920, moths placed in rearing cages at intervals deposited eggs from August 17 to early September. In 1921, moths in rearing cages deposited eggs from early August until the first part of September.

Incubation period.—The incubation period of second-generation eggs was found to be the same as that of the first-generation eggs. In 1920, 73 eggs hatched in from eight to eleven days. The average length of the incubation period was about nine days. A few typical examples selected from many records are included in table 9. Folsom (1909) found that eggs deposited on September 2 hatched on September 7, and states that in Illinois third-generation eggs hatch in five or six days.

TABLE 9. LENGTH OF EGG STAGE OF SECOND GENERATION, 1920

Experiment no.	Leaf no.	Leaflet no.	Date when eggs were deposited	Number of eggs	Date when larval head appeared	Date when eggs hatched	Length of egg stage (days)
300.1....	1	2	August 17	2	August 26	August 27	10
	4	3	17	1	26	27	10
	5	1	17	1	25	26	9
	14	1	17	1	24	25	8
300.2....	2	3	18	1	26	27	9
	3	2	18	1	25	26	8
300.4....	1	1	21	1	30	31	10
	1	2	21	1	29	30	9
300.6....	1	1	24	1	September 1	September 2	9
	1	3	24	2	August 31	1	8
300.7....	8	3	25	1	September 1	3	9
300.12...	4	1	31	5	September 10	11	11

Development.—The first external evidence of development in the second-generation egg, as in eggs of the first generation, is the appearance of two very small, reddish brown, eye-like spots near one end of the egg. In second-generation eggs, these spots appear within from seven to ten days, usually on the seventh day. The next visible stage in the development of second-generation eggs s the appearance of the dark brown head of the caterpillar. This can be distinguished within from seven to ten days, usually about eight days after deposition.

Hatching.—The process of hatch ng in the second generation, and the habits of the young larvae, are the same as in the first generation It is also true of the second generation that some of the eggs do not hatch. For example, in one experiment including 42 eggs, two eggs seemed to be attacked by a fungus and did not hatch.

The larva

Habits.—The second-generation caterpillars attack the same parts of the plant, in the same manner, as do the caterpillars of the first generation. The boring habit which was noticed in the first generation was observed also in reared larvae of the second generation. Caterpillars in rearing cages entered the stem and burrowed within it, depositing the frass at the bottom of the burrow and working some of it out at the leaf axil. Occasionally a few pellets of frass are found scattered along in the burrow. As cold weather approaches, the caterpillars construct cocoons, within which they pass the winter. On October 10 and October 24, 1919, no caterpillars were found in clover heads in a field where on August 16 an average head infestation of 7.12 per cent had been noted. Examinations of the crowns of the plants in the same field revealed the presence of larvae in considerable numbers (table 10, nos. 1 to 4). On November 13 a cocoon was found in the same field, and by November 22 no free caterpillars were found at the crowns of the plants in the field where they had been numerous in late October. On November 24 and November 25, cocoons were found, the caterpillar evidently having gone into hibernation by that time.

TABLE 10. CATERPILLARS FOUND IN PLOTS OF ONE SQUARE YARD IN 1919

Date	Number of plot (one square yard of soil)	Total number of plants in plot	Total number of caterpillars found in plot	Location where caterpillars were found
October 22.....	1	102	8	6 larvae under leaf sheath at crown 1 larva among trash 1 larva in leaf axle
October 23.....	2	98	10	8 larvae under leaf sheaths at crown 1 larva among trash 1 larva, location not noted
October 24.....	3	116	7	4 larvae under leaf sheaths at crown 2 larvae among trash at crown 1 larva in dead stem
October 29.....	4	79	1	1 larva under leaf sheath at crown

Time of appearance.—In 1920, larvae of the second generation first hatched in rearing cages on August 25. In the field, caterpillars were found on September 17 feeding in the heads and at the crowns of clover plants. It is at about this time that the larvae are most noticeable. On November 11 three caterpillars were found, one in a hollow straw on the ground, a second in a cocoon on the ground, and a third, which had not yet spun a cocoon, among stems of clover at the crown of a plant. After that

date no free caterpillars were found, although many cocoons were collected. Some of the reared specimens in the same year spun their cocoons in October.

In 1921, caterpillars were found feeding in the crowns of plants on September 1, and in both heads and crowns on September 15. On September 19 and 23, they were still to be found in the heads. On October 11 both a cocoon and a free caterpillar, partly grown, were found in the field. Reared caterpillars spun their cocoons in late September and early October. One grown caterpillar, which left its cocoon upon being examined, was observed to spin a second cocoon on September 21.

In 1922, larvae that hatched from August 12 to August 15 molted for the last time from August 24 to September 24 (table 13, page 26). These larvae spun cocoons during September and October.

FIGURE 12. WINTER COCOON, × 6

The cocoon.—In the vicinity of Ithaca, New York, the clover-seed caterpillar usually passes the winter as a larva, although pupation sometimes occurs in the fall. The cocoon (figure 12) in which the larva or the pupa spends the winter is constructed of silk and is about 6 to 7 millimeters in length and from 3 to 3½ millimeters in diameter. While the form may vary somewhat, it is typically cylindrical, with rounded ends. In cross section the cocoon is circular in outline. It is constructed of fine silk threads very closely woven together with fine bits of soil and small pieces of the clover plant, forming a tough, flexible, dark brown cocoon. The cylindrical cavity containing the overwintering caterpillar is circular in cross section, and is smooth, the wall being made of silk.

The cocoon is made in the following manner: A caterpillar which was already spun up left its cocoon when it was examined. For about an hour the caterpillar crawled around over the soil and the base of the plant, evidently trying to find a suitable place to spin another cocoon. Finally it came to rest under the leaf sheath of a dead stem of clover. The head of the caterpillar was toward the base of the stem. Soon the caterpillar turned around under the leaf sheath, and began to draw the thin, parchment-like, leaf sheath up close around itself and fasten it with silk threads. Then it reached up, bit out a piece of the dead stem, and spun this in with the silk of its covering. Next, it drew up the sides of the leaf sheath. Finally it closed the distal end of the cocoon by drawing up a small leaf petiole, and more of the leaf sheath. One could distinctly see these parts of the plant move as the caterpillar drew them together. In half an hour the outer wall of the cocoon was complete except for a little place at the distal end. At intervals one could see the whole leaf sheath and the little petiole with its leaflets move, due to the motions of the caterpillar working

within its cocoon. By the end of fifty minutes the caterpillar had closed the opening at the distal end of the cocoon, and to all external appearances the cocoon was finished. The caterpillar, however, continued to work on the inside. After an hour one could still see the leaf sheath, the cocoon, the petiole, and the little petiole with its leaflets, move, due to the movements of the caterpillar within the cocoon. At the end of three hours the caterpillar was still working within its cocoon, for the movements were still in progress.

The cocoon of the clover-seed caterpillar may be found in the field in late autumn, in winter, or in spring. It may lie exposed on the surface of the ground, or among dead clover leaves, or among stems under the plant. It may be partly buried in the soil; or it may be attached to the side of the plant at the crown or at the base of a stem; or it may be formed under a leaf sheath. The caterpillar may enter dead hollow stems of certain plants, such as the straws of wheat. It spins a fine silken lining within the hollow stem, and closes the open end with silk. It was found that caterpillars in such situations pass the winter successfully. For example, caterpillars hibernating in straws were collected on November 19, November 22, and December 14, 1920, and these seemed to be entirely normal the following spring. However, some of the caterpillars that hibernate in hollow stems die during the winter, as is shown by the fact that on December 14, 1920, a dead caterpillar was found within a wheat straw, and on March 8, 1921, another dead caterpillar was found in a similar place.

The cocoon of the clover-seed caterpillar may be attached to plants other than clover. For example, on November 16, 1920, a cocoon was found attached to a stem of grass, and on December 14, 1920, another cocoon was found attached to the side of the crown of sheep sorrel (*Rumex acetosella*).

There is a loss in the number of second-generation caterpillars in the field, due to unknown causes. Dead, partly grown, and full-grown larvae were found in late fall, and dead larvae were found also in the spring. Some of these caterpillars, which had not spun cocoons, were found at the crowns of the plants; others were found dead in cocoons or in stems of wheat on the ground under the plant.

Hibernation in the full-grown larval stage seems to be the rule in the vicinity of Ithaca, New York. However, there is reason to believe that under certain conditions some of the second-generation larvae may pupate in the fall. The caterpillars evidently do not resume feeding in the spring, but remain within their cocoons and later transform. Pupation usually occurs in May and early June, but occasionally it takes place in the fall (table 11).

TABLE 11. PUPATION OF SECOND GENERATION

Specimen no.	Date of pupation
11-11-20-1	May 21, 1921
11-16-20	June 1, 1921
11-22-20-4	May 22, 1921
4-26-21	May 4-22, 1921

TABLE 11 (*concluded*)

Specimen no.	Date of pupation
300 lb-1	May 22 to June 20, 1921
II-1	May 23–31, 1922
V-4	June 1, 1922
VII-1	May 15–18, 1922
VIII-1	May 22–31, 1922
1922–3	September 8, 1922
1922–12	June 6, 1923

Length of larval period.—When the caterpillar pupates in the spring, the length of the larval stage of the second generation is about 278 days. When pupation occurs in the fall, the larval stage is necessarily greatly reduced. In the case of one reared specimen, the larva pupated in 27 days (table 12).

TABLE 12. LENGTH OF LARVAL STAGE OF SECOND GENERATION

Specimen no.	Date when egg hatched	Date of pupation	Length of larval stage (days)
300 lb-1	August 25, 1920	May 22 to June 20, 1921	270–299
V-4	August 27, 1921	June 1, 1922	278
VIII-1	August 27, 1921	May 22–31, 1922	268–277
VII-1	August 30–31, 1921	May 15–18, 1922	257–261
3	August 12, 1922	September 8, 1922	27

FIGURE 13. PUPAL CASE PROJECTING FROM WINTER COCOON, × 4+

The pupa

The second-generation pupa, like the pupa of the first generation, is active. If it is disturbed, it will escape, by quick movements of the abdomen, through one end of its cocoon. A pupa which has thus freed itself of its cocoon will complete its development and produce a normal moth.

The length of the pupal stage in two specimens was found to be 19 days. A larva collected on November 11, 1920, pupated on May 21, 1921, and the moth emerged on June 9, 1921. A reared larva pupated on June 1, 1922, and the moth emerged on June 20, 1922. This indicates that the pupal stage of the second generation is slightly longer than that of the first generation.

In the process of emergence, the pupa makes its way through one end of the

cocoon and the moth escapes. The pupal case is left behind, with its caudal end still inclosed within the opening of the cocoon (figure 13).

INSTARS

During the summer of 1922, an attempt was made to determine the number of instars occurring in the development of the larva. Specimens of both the first and second generations were studied. All the larvae of both generations which emerged transformed to male moths.

The larvae of the first generation molted three and four times, three molts being the more common. In the second generation the larvae molted from three to five times, four molts being the commonest. (Table 13.)

The larvae molted for the first time in from four to seven days after hatching from the egg. The number of days between the molts of the caterpillars was also found to vary. In the first generation this variation ranged from three to six days, four days being the commonest. In the second generation the variation ranged from two to fifteen days, from four to seven days being the commonest. (Table 13.)

SEASONAL HISTORY

In the locality of Ithaca, New York, two generations of moths occur each year, these generations being very distinctly separated in their appearance in the field. While it is possible that under favorable weather conditions there may be a partial third generation, no evidence of a third complete flight of moths at Ithaca has been noted in these studies. Folsom (1909), however, states that in Illinois three generations occur each year.

The earliest moths of the first generation may be seen as scattered individuals throughout the field when the first clover heads appear. In the normal season this is in early June. The moths of this generation gradually increase in numbers until about the middle of June, when they are most numerous. At this time the larvae may be found feeding in the heads and on the tender young growth at the crown of the plant. After the middle of June there is a gradual diminishing in the numbers of the first-generation moths, and the first-generation caterpillars become more noticeable. The flight of the first generation of moths ends about the end of June, and nearly all of the caterpillars have disappeared by late July. The first-generation larvae transform, and the second-generation moths appear, usually in early August. These moths become numerous about the middle of the same month. By the middle of September, many second-generation larvae of various stages may be found feeding in the heads and at the crowns of the second-crop clover. The flight of the second-generation moths ends during the first few days of September.

The second-generation caterpillars feed on the clover plant throughout the fall, and about the middle of October the first cocoons may be found. By late November the larvae have all stopped feeding at the crowns of the plants and have spun cocoons. Folsom (1909) seems to be uncertain concerning this point, for he says: "The fate of the larvae that feed at the crown of the plant in autumn is rather uncertain. The earliest ones probably pupate, and some of the remainder very likely survive the winter as larvae." Folsom states further that he has not been able to find any of the larvae in early spring. At Ithaca, New York, the caterpillar usually

TABLE 13. NUMBER OF INSTARS, FIRST AND SECOND GENERATIONS, 1922

Specimen no.	Date when egg hatched	Generation	Date of first molt	Date of second molt	Date of third molt	Date of fourth molt	Date of fifth molt	Date of of pupation	Sex	Number of molts	Date of emergence
1......	June 28	First	July 2	July 7	July 11	July 16..	....	Aug. 2	Male	4	Aug. 17
4......	June 29	First	July 4	July 8	July 12	....	....	July 29	Male	3	Aug. 11
6......	June 29	First	July 5	July 8	July 12	....	....	July 25	Male	3	Aug. 7
11......	July 2	First	July 8	July 11	July 15	....	....	Aug. 6	Male	3	Aug. 18
12......	July 2	F rst	July 8	July 12	July 18	....	....	Aug. 15	Male	3	Aug. 25
14......	July 2	First	July 8	July 13	July 16	July 21	....	*	.....	4	
18......	July 4	First	July 10	July 13	July 17	....	....	Aug. 5	Male	3	Aug. 18
20......	July 4	First	July 9	July 12	July 16	....	....	July 30	Male	3	Aug. 13
3	Aug. 12	Second	Aug. 17	Aug. 19	Aug. 24	....	....	Sept. 8	.....	3	†
6......	Aug. 12	Second	Aug. 19	Aug. 24	Aug. 31	Sept. 7	....	*	.....	4	
7......	Aug. 12	Second	Aug. 17	Aug. 19	Aug. 23	Aug. 30	....	*	Male	4	June 23–25, 1923
8......	Aug. 13	Second	Aug. 19	Aug. 24	Sept. 1	....	....	*	.....	3	
9......	Aug. 13	Second	Aug. 19	Aug. 25	Aug. 31	Sept. 8	Sept. 12.	*	.....	5	
10......	Aug. 14	Second	Aug. 21	Aug. 25	Aug. 30	Sept. 5	....	*	.....	4	
12......	Aug. 14	Second	Aug. 18	Aug. 24	Aug. 29	Sept. 6	....	June 6,'23	Male	4	June 23–25, 1923
13......	Aug. 14	Second	Aug. 18	Aug. 24	Aug. 30	Sept. 9	Sept. 24.	*	.....	5	
18......	Aug. 15	Second	Aug. 19	Aug. 23	Aug. 27	Sept. 3	....	*	.....	4	
19......	Aug. 15	Second	Aug. 20	Aug. 25	Aug. 28	Sept. 4	....	*	Male	4	June 25–26, 1923

* Specimen died before pupation occurr d.
† Specim:n died before emerg.nce occurred.

passes the winter as a larva in the cocoon, and transforms to a pupa in the following spring, in the latter part of May or early June. The moth emerges in June. In very rare cases, the larva may pupate in the fall.

NATURAL ENEMIES

Comstock (1881) mentions having reared a hymenopterous parasite, *Phanerotoma tibialis* Hald., from a cocoon of the clover-seed caterpillar. According to Ashmead (1890), Miss Murtfeldt reared *Glypta leucozonata* from the clover-seed caterpillar at Kirkwood, Missouri, on July 12, 1887. Gossard (1892) reported *Microdus laticinctus* Cress. as a parasitic enemy of the clover-seed caterpillar at Ames, Iowa.

The writer has reared both *Phanerotoma tibialis* and *Bassus laticinctus* from the clover-seed caterpillar at Ithaca, New York. Three specimens of *Phanerotoma tibialis* emerged from clover-seed caterpillar cocoons in August, 1920. Two other specimens emerged on June 24, 1921, from overwintering cocoons. One of these cocoons contained an apparently normal caterpillar on May 30, 1921; the other caterpillar seemed normal as late as June 6, 1921. In 1920, two specimens of *Bassus laticinctus* emerged from overwintering cocoons of the clover-seed caterpillar which were collected on April 16. One of these cocoons was opened on April 17 and an apparently normal grown caterpillar was noted in it. The parasitized caterpillars appeared to be normal when examined.

METHODS OF CONTROL

A number of recommendations have been made during the past forty years for the control of the clover-seed caterpillar. The first of these suggestions was made by Comstock (1881), who advocated cutting the hay early in June to destroy the immature larvae of the first generation. Osborn and Gossard (1891 a) suggested cutting volunteer clover and disposing of the heads in such a way as to destroy the larvae. The same writers (1891 b) further advocated plowing in October, or in early spring before the end of April. Gillette (1891) also advanced the idea of plowing in October, but with the added recommendation to roll and harrow. Gossard (1892) recommended the following procedure: (1) A field should not be kept seeded with clover longer than three, and preferably not longer than two, years. (2) Newly seeded fields should be located far from old clover fields. (3) The fields should be pastured in the fall. (4) Clover infested in May or June should be cut at once. Strips should be left, on which the moths may oviposit, and these strips should then be cut and the hay destroyed when the moth flight is over. (5) Barnyard manure, when applied to the soil, should be distributed lightly in the spring, in order that it may decay by the following fall.

Sanderson (1902) suggested pasturing the clover in the spring until June 10 or 15, thus securing a late seed crop. Folsom (1909) attests the value of the methods of control recommended by Comstock and by Osborn and Gossard, and states further that these practices aid in the control of several other enemies of clover, at the same time. Haseman (1920) advocated early cutting of the first crop of clover, for the control of the clover-seed caterpillar, the clover-seed midge, and the clover-seed chalcid. He believed that this would destroy the larvae, and would bring on the

blossoms of the seed crop early enough to escape the next generation of the insects. Gossard (1918) recommended pasturing or clipping the clover in the fall of the first year.

So far as the writer has been able to ascertain, there have been no definite experiments conducted for the purpose of determining the value of any method of controlling the clover-seed caterpillar. The cutting of the first crop of clover in early June, as suggested by Comstock, is apparently the best method of reducing the numbers of insects. However, since the caterpillars feed in the crowns of the plants as well as in the heads, it seems that a considerable number escape destruction by such early cutting. For example, in 1921, on July 5, full-grown larvae were found to be fairly numerous under the leaf sheaths at the crowns of the plants immediately after the first crop of clover had been cut. Again on September 1 the larvae were found to be present in considerable numbers at the crowns of the clover plants immediately after the cutting of the second crop. On the same date, in a field that had not yet been cut, the caterpillars were present at the crowns of the plants as well as in the heads. In 1922, on July 19 and July 31, larvae were found at the crowns of the plants after the first crop of clover had been cut. These observations indicate that a considerable number of the caterpillars escape the early-cutting method of control. Plowing under the clover and planting the field to some other crop at the end of two years, would doubtless aid in controlling the clover-seed caterpillar.

CONCLUSIONS

1. Two generations of the clover-seed caterpillar appear in the vicinity of Ithaca, New York, and there is reason to believe that in favorable seasons a partial third generation may occur also.

2. The flight of the moths of the first generation extends from late May or early June until late June or early July. The flight of the moths of the second generation begins in late July or early August, and ends about the first of September.

3. The length of the different stages in the development of the clover-seed caterpillar were found to be as follows:

   (a) Egg stage: about 9 days.
   (b) Larval stage: about 30 days in the first generation and about 278 days in the second generation. (For one specimen which pupated in the fall, the length of the larval stage was 27 days.)
   (c) Pupal stage: about 13 days in the first generation and about 19 days in the second generation.

4. The caterpillars feed at the crowns of the plants and in the heads.

5. The overwintering cocoon is found under the leaf sheaths at the crowns of clover plants, and on the ground under the plants. The cocoon may also be attached to other plants, such as sheep sorrel (*Rumex acetosella*), or it may be formed within hollow stems, such as the straws of wheat. The cocoons may be found in the field in late fall, in winter, and in spring.

6. The number of instars in the specimens studied varied from four to six.

7. In the vicinity of Ithaca, the clover-seed caterpillar passes the winter as a larva in a silken cocoon. There is reason to believe, however, that some of the larvae may pupate in the fall.

8. *Phanerotoma tibialis* Hald. and *Bassus laticinctus*, two hymenopterous parasites, were reared from the clover-seed caterpillar at Ithaca.

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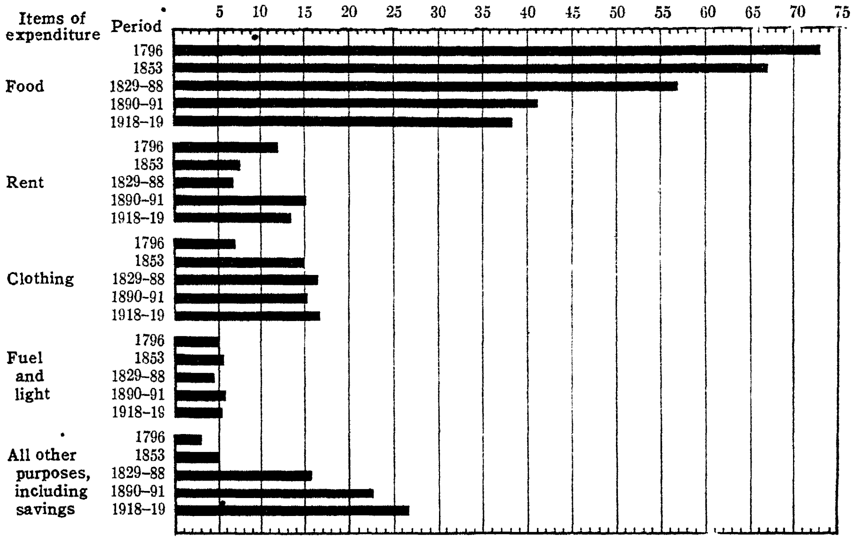
The Cost of Living in a Small Factory Town

Clarence Vernon Noble



PERCENTAGES OF THE TOTAL FAMILY EXPENDITURES FOR THE VARIOUS GROUPS OF LIVING COSTS AT DIFFERENT PERIODS

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CONTENTS

THE COST OF LIVING IN A SMALL FACTORY TOWN[1]

Clarence Vernon Noble

The purpose of the investigation herein reported is threefold: (1) to study living conditions and living costs of persons employed in a factory located in a small town; (2) to make a comparative study of living conditions and living costs of persons employed in a factory and (a) living on farms, (b) living in town and cultivating gardens or keeping livestock, (c) living in town with no gardens nor livestock; (3) to formulate some of the advantages and disadvantages of the small town as a factory site.

METHOD OF STUDY

The survey method was used in making this study. A record sheet similar to the one shown on the last pages of this bulletin was used. The plan was to select a successful manufacturing concern located in a small town, and to visit as many of the employees of that plant as time would permit. The Corona Typewriter Company at Groton, New York, was finally selected as a desirable place to make the survey. The president of the company checked from the factory lists the names of those employees who might be visited, the only condition being that the employees selected should represent heads of households. A total of 113 names was furnished the writer, and of this number of records taken 86 were considered satisfactory for the work in hand. During the course of the survey there were six additional records taken of employees of other manufacturing concerns in Groton. These also were used in the study, making a total of 92 records. Each record covers the receipts and expenditures of one family for the year beginning September 1, 1918, and ending August 31, 1919. The data were obtained by questioning members of each household and getting their best estimates on each detail of the record blank.

Complete records of receipts and expenses were found in only 2 of the 92 homes visited. However, in most homes there were records which were of more or less value in helping the person giving the data to make his estimates. While no claim is made that the estimates obtained were absolutely accurate, it is the writer's belief that the average of these estimates is reasonably accurate and is fairly representative of the married employees of the Corona Typewriter Company.

LOCATION AND DESCRIPTION OF AREA STUDIED

Groton is located in the northeastern part of Tompkins County, New York. The Fair Haven, Auburn, Owego & Sayre branch of the Lehigh Valley Railroad passes through the village, and an improved state road

[1] Also presented to the Faculty of the Graduate School of Cornell University, September, 1920, as a major thesis in partial fulfillment of the requirements for the degree of doctor of philosophy.

Author's acknowledgments. This investigation was conducted under the direction of Professor G. F. Warren. The president of the Corona Typewriter Company furnished valuable aid in getting the work started. The families of Groton, New York, furnished the data on which the study is based. Mr. D. G. Card assisted in collecting the data. To these and to many others who helped with the work, the writer is indebted.

connects it with Auburn to the north and with Ithaca to the south. The population of Groton on January 1, 1920, was 2235.[2]

The Corona Typewriter Company is by far the largest industrial plant in the village. On September 1, 1919, this company had in its employ approximately 800 individuals, of whom about 500 were men and about 300 were women. Not all of these employees, however, claimed Groton as their home. Many of the unmarried employees whose homes were in near-by towns, boarded in Groton during the week and spent their week-ends at home. Others either drove to and from their homes with their own cars, or made the trip in the motor busses which were operated by the company. At the time this survey was taken there were four of these company-operated motor busses, three seating twenty-five persons each and a smaller one seating fifteen persons. Two of the large busses made trips every workday to Moravia, which is about ten miles north of Groton. Two of the employees of the company, whose homes were in Moravia, drove these busses. By this arrangement only one trip a day was necessary, as the busses remained in Moravia overnight. The third large motor bus was operated between Groton and Freeville, about five miles to the south, under the same arrangement. The small bus was used for employees living in Locke, about six miles north of Groton. This bus was driven by a man who lived in Groton, so that two trips daily were necessary. The fare on these busses, if paid in advance, was $2.40 a week to Moravia, and $2.10 a week to Locke or Freeville.

Other industrial plants located at Groton are the American Road Machinery Company, the Groton Bridge and Manufacturing Company, the Groton Electrical Devices, and the Jersey Milk and Cream Company.

The elevation of the village varies from about 1000 feet to 1200 feet. All of the industrial plants and business establishments are situated along the railroad in the Owasco Lake inlet valley extending north and south through the town. The residential sections rise to the higher elevations in the east and west. The principal soil types are the Dunkirk gravelly loam in the valley and the Dunkirk gravelly sandy loam on the hillsides. Both of these soil types are excellent for gardening. A growing season of about 150 days, and a rainfall during the growing season of from 16 to 18 inches, give the gardeners of this region favorable climatic conditions for growing a wide variety of vegetables and fruits.

MEMBERS OF THE HOUSEHOLDS

The 92 homes visited had a membership of 395 persons for all or part of the year from September 1, 1918, to August 31, 1919 (table 1). The word *family* is used here to include those members of the household who contribute all of their earnings to the general family fund or are entirely dependent on this fund for support. *Self-supporting* includes those members of the household who contribute a definite sum for privileges received. *Household* is used as an all-inclusive word to cover all persons in a home.

All of the families visited were white, and most of the husbands and wives had been born in Groton, on near-by farms, or in neighboring towns or villages.

[2] Fourteenth Census of the United States, vol. 1, Population, p. 261. 1920.

TABLE 1. MEMBERS OF 92 HOUSEHOLDS IN GROTON, NEW YORK

	Number
Family:	
Husbands	91
Wives*	92
Sons	65
Daughters	48
Husbands' grandmothers	2
Husbands' mothers	2
Husband's father	1
Husband's niece	1
Wife's grandmother	1
Wives' mothers	5
Wives' fathers	2
Wife's cousin	1
Grandchildren	6
Daughters-in-law	2
Hired girls	2
Self-supporting:	
Roomers and boarders:	
Sons	3
Daughters	5
Others	34
Roomers only	12
Boarders only	20
Total	395

* One was widowed.

HUSBANDS

Nationality

Of the 91 husbands, 86, or 95 per cent, were natives of the United States. Other nationalities were represented by two Englishmen, one German, one Bohemian, and one South American.

Age

The average age of all husbands was 39 years, but since a few of them were somewhat advanced in years, thus making the average non-representative of the group as a whole, the median age is more significant. This was 35 years.

Schooling

Only one of the husbands had completed a college course, while four others had received some college training. Eight of the men were high-school graduates, one had attended high school for four years, ten for three years, seventeen for two years, and eight for one year. The remaining forty-two husbands had received only district- or grammar-school training, and twenty-six of these had not even completed the work prescribed in these elementary schools. To summarize, 46 per cent of the husbands had not attended high school, 48 per cent had received more or less high-school training but had not entered college, and about 5 per

cent had attended college but only one individual had completed the college work.

WIVES

Nationality

Of the 92 wives, 88 had been born in the United States. Canada, Germany, Sweden, and Bohemia each had one representative among the wives.

Age

As would be expected, the average age of all wives was below that of the husbands, it being 35 years. The median age was 33 years for wives, or two years younger than the corresponding figure for husbands.

Schooling

The wives had received better schooling than had their husbands. Three of them were college graduates, and eight others had attended college for varying periods. There were twelve high-school graduates among the wives, one had attended high school for four years, ten for three years, nine for two years, and fifteen for only one year. This left thirty-four wives who had received only elementary-school training, and twenty-two of these did not complete the work in these schools. Thus, 37 per cent of the wives received less than high-school training, 51 per cent were enrolled for varying periods in high schools but did not attend college, and 12 per cent entered college with three persons completing their college courses.

CHILDREN

There were no foreign-born children in the 92 homes studied. The average age of all sons at home was 9.9 years, and for all daughters at home 9.4 years. The median ages were 6 years for the sons and 7 years for the daughters. The ages of the children at home are given in table 2:

TABLE 2. AGES OF CHILDREN AT HOME
(67 families, Groton, New York)

Age (years)	Males	Females	Total	Age (years)	Males	Females	Total
Under 1	2	3	5	9–10	3	5	8
1–2	4	2	6	10–11	3	3	6
2–3	9	3	12	11–12	1	3	4
3–4	6	6	12	12–13	5	2	7
4–5	3	1	4	13–14	1	..	1
5–6	3	4	7	14–15	1	..	1
6–7	6	4	10	15–16	1	1	2
7–8	3	2	5	16–17	..	5	5
8–9	2	..	2	17 or over	12	4	16

Many of the families visited showed deep interest in the Groton school system, and all persons with children seemed very anxious that their children should at least complete the work in the local high school. Of the children of high-school age, 50 per cent of the sons and 43 per cent of the daughters had left school before completing the high-school work.

All of the children lived within convenient walking distance of the schools. The longest distance that any child was required to walk was approximately one mile.

SIZE OF IMMEDIATE FAMILY

The average size of the immediate family (including husband, wife, and children) in the 92 homes studied was 3.3 persons at home, or 3.6 persons when the fifteen sons and sixteen daughters who were not at home at any time during the year were considered. The number of children per family, including the children not at home, is shown in table 3:

TABLE 3. SIZE OF IMMEDIATE FAMILIES
(92 households, Groton, New York)

Families having	Wives under 45 years old	Wives 45 years old or older	Total	
			Number	Per cent
No children	22	3	25	27.2
1 child	26	8	34	37.0
2 children	11	2	13	14.1
3 children	4	1	5	5.4
4 children	3	3	6	6.5
5 children	2	3	5	5.4
6 children	2	1	3	3.3
10 children	1	0	1	1.1

SELF-SUPPORTING MEMBERS OF HOUSEHOLD

In the families studied, there were three sons and five daughters who were working in Groton but were paying for their rooms and board at their homes. In addition to these members of the immediate family, 34 roomers and boarders, 12 roomers only, and 20 boarders only (table 1, page 7), were members of the 92 households for all or a part of the year covered by the survey.

ADULT-MALE-EQUIVALENT UNIT

The most important step in making an analysis of the 92 budgets included in this study, was considered to be the reducing of all households to some common basis. The units of comparison used by different investigators have been the per-family, per-capita, adult-equivalent, and adult-male-equivalent units. The per-family unit is misleading, not only because of the variation in the size of families, but also because of the age and sex composition of families having the same number of individuals. The per-capita unit eliminates the first objection made to the per-family unit, but still fails to recognize the varying requirements for individuals of different sex and age. The adult-equivalent method, used by some investigators, is to count two children as equal in their demands to one adult, and thus reduce all families to the adult equivalent, regardless of sex. Some writers have used this method without any regard to the ages of the children. One investigator (Funk, 1918:5, footnote) has considered a child of 12 years of age or less as equivalent to one-half an adult,

and all persons older as adults. This, of course, is only approximate, because much depends on the age and sex of the children and the sex of the other members of the household. The adult-male-equivalent unit appears to be the best unit yet devised for making a study of this kind. It is based on the food requirements of individuals of different sexes and ages, reducing each member of the household to its equivalent in consuming power to an adult male represented as 100.

In arriving at the adult-male-equivalent figure, there seems to be a difference of opinion. The units adopted by the United States Labor Commissioner (1891) in his investigations of 1890–91 were as follows:

	Units
Adult male	100
Adult female	90
Child of 11 to 14 years, inclusive	90
Child of 7 to 10 years, inclusive	75
Child of 4 to 6 years, inclusive	40
Child of 3 years or under	15

These units are purely arbitrary, not being based on any scientific data as to the relative consuming power of women and children as compared with that of an adult male. These units are still in use by the Bureau of Labor Statistics of the United States Department of Labor (1919 a:148).

Another system for getting the adult male equivalent was proposed by Engel (1895: 5). This method starts with one unit at infancy, represented by unity, and adds one-tenth of a unit for each advancing year up to the age of 20 for females and 25 for males. This is purely arbitrary. Engel's object was to furnish a means by which all other expenditures, as well as that for food, of families of different composition might be reduced to some common unit for comparison.

The method of the Office of Experiment Stations, United States Department of Agriculture (Langworthy, 1908:365), appears to be the only truly scientific method yet devised for reducing families to the adult male equivalent in food consumption. This method is based on more than five hundred dietary studies made in the United States and other countries. The values are given in table 4:

TABLE 4. RELATIVE VALUES FOR FOOD REQUIREMENTS OF PERSONS OF DIFFERENT AGES AND OCCUPATIONS AS COMPARED WITH A MAN IN FULL VIGOR AT MODERATE WORK

Man, period of full vigor:	
At moderate work	100
At hard work	120
In sedentary occupation	80
Woman, period of full vigor:	
At moderate work	80
At hard work	100
In sedentary occupation	70
Man or woman:	
In old age	90
In extreme old age	70–80
Boy:	
15 to 16 years old	90
13 to 14 years old	80

TABLE 4 (*concluded*)

Boy (*continued*):	
12 years old	70
10 to 11 years old	60
Girl:	
15 to 16 years old	80
13 to 14 years old	70
10 to 12 years old	60
Child:	
6 to 9 years old	50
2 to 5 years old	40
Under 2 years old	30

Although approximately the same results would be reached by the use of any one of the three methods noted above, the units devised by the United States Department of Agriculture seem to be nearest to the truth. Accordingly these units are employed in the present study. No satisfactory set of units has yet been devised for comparing families of different composition with reference to expenditures other than food. Therefore the food units are used for all comparative purposes in this work, due consideration being given, of course, to the members of the household who should be included in figuring each class of receipt or expense.

LIVING CONDITIONS AND LIVING COSTS OF PERSONS EMPLOYED IN FACTORIES LOCATED IN A SMALL TOWN

FAMILY INCOME

The average annual income of the 92 families studied, showing the amount and the percentage of the total income derived from the various sources, is given by income groups in table 5.

An attempt was made to ascertain the total receipts for the year for each member of the family who contributed all earnings to the general family fund. The receipts from husbands and wives are divided into "Cash" and "Not cash" in table 5, the "Not cash" representing some commodity furnished in return for work performed. The footnotes to the table denote the commodity received. The wives' receipts are divided into receipts "From roomers and boarders" and receipts "From other sources." Gifts to any member of the family were not considered as receipts, nor was any attempt made to ascertain the expense for gifts made by members of the family.

The receipts from farms, gardens, and livestock are gross, the "cash" receipts representing the quantity of products sold and the "not cash" receipts representing primarily the quantity of home-produced food used in the homes.

It is shown in table 5 that the average family income for the year was $2013.43. Of this amount the husbands contributed 75.5 per cent, the wives 13.8 per cent, the children 2.2 per cent, and other members of the family 0.5 per cent. The remaining 8 per cent was made up of receipts from farms, gardens, and livestock.

When the data are studied by income groups, it may be noted that, although the total family income increased approximately 97 per cent

TABLE 5. AVERAGE ANNUAL INCOME, SHOWING AMOUNT AND PERCENTAGE DERIVED FROM EACH SOURCE

(92 families, Groton, New York)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	29	34	29	92
Adult male equivalent	2.12	2.56	2.70	2.46
Receipts from:				
Husbands:				
Cash	$1,064.86	$1,490.06	$2,002.28	$1,517.49
Not cash	9.14*	....	5.38†	4.58
Total	$1,074.00	$1,490.06	$2,007.66	$1,522.07
Wives:				
From roomers and boarders:				
Cash	$ 16.38	$ 96.68	$293.66	$133.46
Not cash	....	7.06§	8.28§	5.23
From other sources:				
Cash	102.41	154.53	132.14	131.04
Not cash	9.93‡	....	14.34‖	7.64
Total	$128.72	$258.27	$448.42	$277.37
Sons — cash	$24.34	$23.29	$79.86	$41.46
Daughters — cash	....	$3.79	$4.10	$2.70
Other members of family — cash	$22.76	....	$6.03	$9.08
Farms, gardens, or livestock:				
Cash	$69.90	$31.71	$ 69.07	$ 55.52
Not cash	78.72	96.88	141.52	105.23
Total	$148.62	$128.59	$210.59	$160.75
Total family income, all sources:				
Cash	$1,300.65	$1,800.06	$2,587.14	$1,890.75
Not cash	97.79	103.94	169.52	122.68
Total:				
Per family	$1,398.44	$1,904.00	$2,756.66	$2,013.43
Per adult male equivalent	$658.79	$744.86	$1,021.11	$816.87
Per cent of total income derived from:				
Husbands	76.9	78.2	72.9	75.5
Wives	9.2	13.6	16.3	13.8
Sons	1.7	1.2	2.9	2.1
Daughters	....	0.2	0.1	0.1
Other members of family	1.6	....	0.2	0.5
Farms, gardens, or livestock	10.6	6.8	7.6	8.0

* Wood, butter, cream, and cheese in return for work.
† Board and room in return for work.
‡ Board in return for housework.
§ Rent in return for board and room.
‖ Board and room in return for housework.

from the lowest to the highest income group, the increase in that part of the income contributed by the husband was only about 87 per cent for the same groups. The proportion of the total family income contributed by the husband decreased from 76.9 per cent in the lowest income group to 72.9 per cent in the highest income group. On the other hand, the amount contributed by the wife increased from 9.2 per cent in the lowest income group to 16.3 per cent in the highest. The percentage of the total family income derived from the children and other members of the family was small in all groups.

The adult male equivalent averaged 2.46 for the 92 families. The size of the family increased directly with the family income. The average annual income per adult male equivalent was $816.87 for all families. The average income per adult male equivalent increased about 55 per cent from the smallest to the largest income group. As previously stated, the average family income increased approximately 97 per cent for the same groups.

Thus far the amount of the family income derived from each source has been presented as the average for the total number of budgets in each group, regardless of the number of persons contributing from each source. In the case of husbands, of course, there would be very little difference, since there was but one family without income from this source. The number of persons contributing from each source, and the average amount contributed by each, are given in table 6:

TABLE 6. SOURCES OF INCOME, SHOWING THE NUMBER CONTRIBUTING FROM EACH SOURCE AND THE AVERAGE AMOUNT CONTRIBUTED BY EACH

(92 families, Groton, New York)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	29	34	29	92
Average family income	$1,398.44	$1,904.00	$2,756.66	$2,013.43
Source of income:				
Husbands:				
Number contributing	28	34	29	91
Average amount contributed	$1,112.36	$1,490.06	$2,007.66	$1,538.79
Wives:				
Number contributing	14	23	21	58
Average amount contributed	$266.64	$381.78	$619.24	$439.97
Sons:				
Number contributing	1	2	3	6
Average amount contributed	$706.00	$396.00	$772.00	$635.67
Daughters:				
Number contributing	....	2	2	4
Average amount contributed	....	$64.50	$59.50	$62.00
Other members of family:				
Number contributing	1	....	1	2
Average amount contributed	$660.00	....	$175.00	$417.50
Receipts from farms, gardens, or livestock:				
Number contributing	24	25	26	75
Average amount contributed	$179.58	$174.88	$234.88	$197.19

Not only did the proportionate number of wives contributing to the family fund increase directly with the family income, but the average amount contributed also increased in the same manner. Fifty-eight, or about 63 per cent of the wives, contributed an average of $439.97 to the family income. The largest proportion of this amount was pay from roomers and boarders, or for doing extra work at home such as dressmaking and laundry. However, a considerable number of the wives were working in the factory and doing their housework in the mornings and the evenings and on Saturday afternoons.

Six sons, four daughters, and two other members of the family, each contributed an average of $635.67, $62.00, and $417.50, respectively, to the family income.

Seventy-five of the 92 families visited had more or less receipts from farms, gardens, or livestock. The average receipts from this source were $197.19 per family.

FAMILY EXPENSES

The family expenses for the 92 homes under discussion are considered in averages per family and per adult male equivalent. The adult male equivalent used differs with the various kinds of expenses. Upkeep or rent, light, heat, water, and telephone, were considered expenses for the family for the entire year, and for roomers for the number of months they were in the household. The adult male equivalent used for board, for purchased food, and for farm and garden expenses, includes all persons in the household, with the exception of roomers, for the period of the year they were boarded. For all other expenses, the adult male equivalent used includes the family for the period of the year at home.

The average annual costs of upkeep or rent, light, heat, water, and telephone, are given in table 7:

TABLE 7. AVERAGE ANNUAL COSTS OF UPKEEP OR RENT, LIGHT, HEAT, WATER, AND TELEPHONE

(92 families, Groton, New York)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	29	34	29	92
Average family income	$1,398.44	$1,904.00	$2,756.66	$2,013.43
Adult male equivalent	2.25	2.88	3.29	2.81
Upkeep or rent:				
Per family	$181.97	$177.88	$246.03	$200.65
Per adult male equivalent	80.81	61.65	74.73	71.35
Light:				
Per family	12.21	16.76	19.86	16.30
Per adult male equivalent	5.42	5.82	6.03	5.80
Heat:				
Per family	74.28	86.95	90.89	84.19
Per adult male equivalent	32.99	30.18	27.61	29.94
Water:				
Per family	3.69	4.97	7.66	5.41
Per adult male equivalent	1.64	1.73	2.33	1.92
Telephone:				
Per family	4.14	3.12	3.41	3.53
Per adult male equivalent	1.84	1.08	1.04	1.26

Upkeep or rent

Five of the families included in the survey were boarders, leaving a total of 44 owned and 43 rented homes for a comparative study. The data are given in table 8.

The general tendency was for both owners and renters to live in better homes as the family income increased. The average value of the owners' houses in each income group was somewhat higher than the average value that renters placed on their dwellings. The average value of the 44 owned dwellings exceeded by slightly more than $500 the average value of the 43 rented dwellings. In addition to the dwelling, the owned homes possessed other buildings, such as garages, henhouses, and barns, averaging approximately $260 per home. In the case of the rented homes, the estimated value of other buildings averaged only about $23.

The second method of comparing owned and rented homes was by the number of rooms, excluding bathrooms, in each house. The average for the owned homes was 7.9 rooms, and for the rented homes 6 rooms. Of the owned dwellings, 25 per cent had neither bath nor inside toilet, 5 per cent had only the inside toilet, and 70 per cent had bath and inside toilet. Of the rented homes, 21 per cent were without bath and inside toilet, 14 per cent had only the inside toilet, and 65 per cent had bath and inside toilet. There were no legal building requirements in Groton for either owned or rented homes.

The third method used for making the comparative study of homes was to ask each home owner as to the probable yearly rental value of his property. The averages for these estimates are given in table 8, with the average annual rent paid by the renters. The results are consistent with the other two methods used; that is, the average estimate of the probable rental value of owned homes was somewhat higher than the average rent actually paid by the renters.

The final method used in studying the homes was to classify each as to general appearance. The purpose of this classification was to take into consideration all the important points about each home and arrange the homes in three arbitrary classes, "good," "medium," and "poor," placing about half of the homes in the "medium" group and about a quarter of them in each of the other two groups. These comparisons were made, of course, by taking the homes of Groton as a standard. The results of this classification are again in favor of the owned homes, since there were 32 per cent of these, and only 14 per cent of the rented homes, classified as good. Only 9 per cent of the owned homes were classified as poor, whereas 30 per cent of the rented homes fell in that class.

The residents of Groton take great pride in their homes, and home ownership is increasing very rapidly. Every encouragement is offered the citizens to own their homes. There is a well-organized Savings and Loan Association, whose members are given every opportunity to become householders. The Groton Chamber of Commerce, through its secretary, keeps the residents well informed as to homes and building lots for sale, and has on hand a large number of building plans and blue prints which the citizens are at liberty to study at any time. In addition to these incentives, the Corona Typewriter Company has built a number of comfortable houses with the idea of selling them to its employees at approxi-

TABLE 8. Comparison of Owned and Rented Homes

(87 families, Groton, New York)

Family income group	Number in group	Average family income	Average value of house	Average value of other buildings	Average number of rooms	Per cent of houses having			Probable yearly rental compared with rent paid	General appearance of homes		
						Neither bath nor toilet	Bath and toilet	Toilet only		Good (per cent)	Medium (per cent)	Poor (per cent)
$1600 or less:												
Homes owned	13	$1,449.62	$2,138.46	$383.08	7.7	31	61	8	$221.77	23	62	15
Homes rented	13	1,346.15	1,826.92	....	5.7	15	70	15	172.88	15	62	23
$1601 to $2000:												
Homes owned	15	2,023.33	2,487.33	145.33	7.6	33	60	7	237.60	40	53	7
Homes rented	18	1,817.61	1,750.00	26.67	5.0	28	61	11	174.36	11	50	39
Over $2000:												
Homes owned	16	2,874.19	2,895.31	266.44	8.3	12	88	0	294.38	31	63	6
Homes rented	12	2,648.67	2,666.67	43.75	6.8	17	66	17	212.75	17	58	25
All groups:												
Homes owned	44	2,163.23	2,532.61	259.61	7.9	25	70	5	253.57	32	59	9
Homes rented	43	1,907.00	2,029.07	23.37	6.0	21	65	14	185.16	14	56	30

mately construction cost. The terms of sale are extremely liberal, and a number of the employees are already taking advantage of this opportunity. One of the insistent needs of the town is an increased number of homes for its workers, and it appears as though the above-mentioned agencies will help to meet this need in the near future. In spite of the abnormal costs of construction work in 1919, the writer counted no less than thirty houses under construction in September of that year. Most of these houses were to be occupied by their owners.

A comparison of the upkeep costs of owned homes with the rent paid for rented homes is shown in table 9. The upkeep costs, consisting of taxes, fire insurance, repairs and improvements, and interest on mortgages and on money invested, are given in detail in the table by income groups, with the comparative rental figures in the total columns. These costs are classified into those paid for by actual outlays of cash, and those not paid for in cash. For example, the "interest on investment" column is subdivided to distinguish between the cash interest payments on mortgages and the equally legitimate charge for interest on the money tied up in the home. Of the 44 owned homes, 28 were mortgaged. The average amount of mortgage on these 28 homes was $1741.25. There was no depreciation on any of the owned homes, as the repairs more than maintained the value of the property.

In most instances the cash outlay for the upkeep of owned homes was less than the cash cost of rent for the rented homes, the comparative figures being $146.70 for each owned home and $165.74 for each rented home. However, when all costs were considered, the average upkeep costs and interest on owned homes exceeded the average rental charges for the rented homes. The percentage of the value of owned homes represented by upkeep and interest costs averaged practically the same as the percentage of return on investment in rented homes.

Not all of these families had been in the owner or the renter class for the entire year. In order, therefore, to make a fairer comparison, the average number of months that the homes were owned or rented was placed in the next to the last column of the table. The last column gives the comparative monthly cost of the owned and the rented homes. In every case, the owned homes cost the more when interest was included, but they were also better homes. The average monthly cost of upkeep and interest on all owned homes was approximately $4 higher than the average monthly rent paid for the rented homes.

Light

Two-thirds of the families used electric lights, and one-third used kerosene. The average annual cost of lights of all kinds for all families was $16.30 per family, or $5.80 per adult male equivalent (table 7). There was a considerable increase in the cost of lighting per family as the family income became larger, though the increase per adult male equivalent was small. The families that used electric lights, omitting the 6.7 families where the light cost was included in the rent, averaged 251.6 kilowatt-hours per family, or 89.9 kilowatt-hours per adult male equivalent. The families with kerosene lights averaged 76.2 gallons of kerosene per family, or 24.7 gallons per adult male equivalent. The cost per family for electric

TABLE 9. COMPARISON OF UPKEEP OF 44 OWNED HOMES WITH RENT OF 43 RENTED HOMES IN GROTON, NEW YORK

Family income group	Number in group	Average family income	Average annual cost of					Total cost of upkeep		Less appreciation (not cash)	Net cost of upkeep for owned homes and rent for rented homes				Average number of months used during the year	Cost per month used
			Taxes (cash)	Fire insurance (cash)	Repairs and improvements (cash)	Interest on investment at 6 per cent		Cash	Not cash		Cash	Not cash	Total	Per cent of value of home		
						Cash	Not cash									
$1600 or less:																
Homes owned	13	$1,449.62	$37.46	$4.92	$46.54	$18.62	$124.00	$107.54	$124.00	$15.38	$107 54	$108.62	$216.16	9.0	11.8	$18.25
Homes rented	13	1,346.15	.....	.....	......	......	......	.....	.....	.....	155 15	.....	155.15	9.5	10.8	14.41
$1601 to $2000:																
Homes owned	15	2,023.33	33.20	4.13	44.53	37.00	77.53	118.86	77.53	26.67	118.86	50.86	169.72	7.5	10.5	16.22
Homes rented	18	1,817.61	.....	.....	......	......	......	.....	.....	.....	155.39	13.33	168.72	9.8	11.6	14.53
Over $2000:																
Homes owned	16	2,874.19	46.56	6.06	99.88	52.25	90.81	204.75	90.81	67.19	204.75	23.62	228.37	9.6	9.4	24.36
Homes rented	12	2,648.67	.....	.....	......	......	......	.....	.....	.....	192.75	20.00	212.75	7.8	12.0	17.73
All groups:																
Homes owned	44	2,163.23	39.32	5.02	65.25	37.11	96.09	146.70	96.09	38.07	146.70	58.02	204.72	8.7	10.5	19.54
Homes rented	43	1,907.00	.....	.....	......	......	......	.....	.....	.....	165.74	11.16	176.90	9.0	11.5	15.43

lights was $19.73 and for kerosene $13.76. The cost per adult male equivalent was $7.05 for electric lights and $4.47 for kerosene.

Heat

Furnaces were used in 56 of the 92 homes, but in 6 of these homes the cost of heating was included in the rent. The other 36 homes were heated by stoves. Kerosene stoves were used in 55 homes and gasoline stoves in 2 homes. The kerosene and gasoline stoves were used primarily for cooking, to supplement the coal or wood stoves.

The average quantities of fuel used per family for heating and cooking were 7.5 tons of coal, 1.6 cords of wood, and 33.9 gallons of kerosene and gasoline. The average cost of all fuel was $84.19 per family, or $29.94 per adult male equivalent (table 7). The cost per family increased with the family income, but the cost per adult male equivalent decreased slightly with increasing family income. The amount of coal used increased, and the amount of kerosene used decreased, with the rise in the family income.

A comparison of furnace heat and stove heat indicates that families having furnace heat use more coal and less wood than do families having stove heat. The average cost per family of all fuel for heating and cooking was $100.68 for families having furnaces, and $75.33 for families having stove heat. The cost per adult male equivalent was also higher for the families that had furnace heat.

Water

Seventy-five of the homes were furnished with water from the town water-mains. For 12 of these homes, however, the water cost was included in the rental charge. Of these 75 families, 5 had the following sources of water to supplement that of the town system: outside pumps, 2 families; an outside pump and a cistern in the cellar, 1 family; a kitchen pump connected with a cistern in the cellar, 1 family; an inside pump, 1 family. The 17 families who did not receive water from the town water-supply system obtained their water from the following sources: 7 had water piped into their houses from a spring; 3 had pumps outside and a spring; 1 had a pump outside operated by a windmill; 1 had a pump outside, and a cistern in the cellar from which water was carried; 1 had a pump outside, a spring, and a kitchen pump connected with a cistern in the cellar; 1 had a pump outside operated by a gasoline engine, and a kitchen pump connected with a cistern in the cellar; 1 had a pump outside, and a kitchen pump connected with a cistern in the cellar; 1 had a pump inside; 1 had an artesian well outside.

The average annual cost of water for all families was $5.41 per family, or $1.92 per adult male equivalent (table 7). The water cost increased with the total family income, both per family and per adult male equivalent. For the families that used town water only, the average cost was $7.35 per family, or $2.55 per adult male equivalent. For the families having no town water, the average cost was $2.06 per family, or 67 cents per adult male equivalent.

Telephone

Only 20 of the 92 families had telephones in their homes. The average cost per family having a telephone was $16.25. Telephones were considered

an unnecessary expense by many of the families visited, because of the small size of the town and the consequent nearness of all residents to the business section. When the division is made between the families living on farms and those living in town, about 46 per cent of the farm families, and only approximately 18 per cent of the town families, had telephones.

The average annual cost for telephone use for all families was $3.53 per family, or $1.26 per adult male equivalent (table 7).

Board

Five of the families visited boarded for the entire year. Four of these families consisted of the husband and the wife only, and in the fifth family there was one small son. In addition to these five, ten other families had greater or less expenses for board during the year. In some cases the entire family had boarded for a short time, while in other cases only certain members of the family had had this expense. In a few instances the cost was merely for the husband's lunches at the factory in case he lived too far away to go home at noon.

The annual cost for board is here calculated in the same manner as all other costs, by using the total number of households as a unit. In table 10 the costs are presented by income groups, divided into cash and not cash, and the total costs are given per household and per adult male equivalent.

TABLE 10. AVERAGE ANNUAL COST OF BOARD

(92 households, Groton, New York)

Family income group	Number in group	Average family income	Adult male equivalent	Average cost for all households			
				Cash per household	Not cash per household	Total	
						Per household	Per adult male equivalent
$1600 or less......	29	$1,398.44	2.17	$62.17	$ 9.93	$72.10	$33.26
$1601 to $2000....	34	1,904.00	2.83	41.53	......	41.53	14.65
Over $2000........	29	2,756.66	3.52	38.03	12.55	50.58	14.38
All groups.........	92	2,013.43	2.84	46.93	7.09	54.02	19.02

In a number of instances a member of the family performed some kind of work and received in return board instead of cash. The value of such meals is included here, and the value of the work was included under "not cash" in the total family income (table 5, page 12). The total annual expense for board for all households amounted to $54.02 per household, or $19.02 per adult male equivalent (table 10).

Purchased food

The average cost of all purchased food for the year is given by income groups in table 11. The cost of all purchased food averaged $627.16 per household, or $220.83 per adult male equivalent. A detailed discussion of all food used is given on pages 48 to 56.

TABLE 11. AVERAGE ANNUAL COST OF ALL PURCHASED FOOD
(92 households, Groton, New York)

Family income group	Number in group	Average family income	Adult male equivalent	Average cost: Per household	Average cost: Per adult male equivalent
$1600 or less	29	$1,398 44	2.17	$452.38	$208.70
$1601 to $2000	34	1,904.00	2.83	609.53	215.02
Over $2000	29	2,756.66	3.52	822.62	233.79
All groups	92	2,013.43	2.84	627.16	220.83

Miscellaneous expenses

All expenses not otherwise classified are grouped in alphabetical order under the heading *Miscellaneous expenses*, and are presented, by income groups, per family and per adult male equivalent. in table 12. The averages are given for the total number of families in each income group, regardless of the number of families having each kind of expense.

TABLE 12. AVERAGE ANNUAL MISCELLANEOUS EXPENSES
(92 families, Groton, New York)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	29	34	29	92
Average family income	$1,398.44	$1,904 00	$2,756.66	$2,013.43
Adult male equivalent	2.12	2.56	2.70	2.46
Automobiles:				
Per family	$ 27.72	$ 20.03	$ 79.38	$ 41.16
Per adult male equivalent	13.06	7.84	29.40	16.70
Books, papers, and magazines:				
Per family	12.38	12.24	16.03	13.48
Per adult male equivalent	5.83	4.79	5.94	5.47
Car fare:				
Per family	0.93	1.30	....	0.77
Per adult male equivalent	0.44	0.51	....	0.31
Charity:				
Per family	6.69	7 91	8.45	7.70
Per adult male equivalent	3.15	3.10	3.13	3.12
Church:				
Per family	15.90	21.26	25.21	20.82
Per adult male equivalent	7.49	8.32	9.34	8.45
Clothing:				
Per family	141.10	168.56	219.93	176 10
Per adult male equivalent	66.47	65.94	81.47	71.45
Doctors, dentists, and medicine:				
Per family	56.97	83.26	70 00	70.79
Per adult male equivalent	26.84	32.57	25.93	28 72
Domestic help:				
Days — per family	(6.3)	(4.2)	(4.5)	(5.0)
per adult male equivalent	(3.0)	(1.6)	(1.7)	(2.0)
Cost — per family	$7.83	$5.03	$9.83	$7.42
per adult male equivalent	3.69	1.97	3.64	3.01

TABLE 12 (*concluded*)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	29	34	29	92
Average family income	$1,398 44	$1,904 00	$2,756 66	$2,013.43
Adult male equivalent	2 12	2 56	2.70	2.46
Educational:				
Per family	$ 9.38	$ 5 44	$34.34	$15.79
Per adult male equivalent	4.42	2.13	12.72	6.41
Entertainment:				
Per family	20.21	36.97	24.38	27.72
Per adult male equivalent	9.52	14.46	9.03	11.25
Furniture:				
Per family	32 59	54.59	53.03	47.16
Per adult male equivalent	15 35	21.36	19.64	19.13
Furniture insurance:				
Per family	1.48	1.24	2.03	1.57
Per adult male equivalent	0.70	0.48	0.75	0.64
House supplies:				
Per family	10.97	21.97	22.17	18.57
Per adult male equivalent	5.17	8.60	8.21	7.53
Laundry:				
Per family	13.24	24 68	27 90	22.09
Per adult male equivalent	6 24	9 65	10.33	8.96
Life insurance:				
Per family	26 45	39.15	50.83	38.83
Per adult male equivalent	12.46	15.31	18.83	15.75
Organization dues:				
Per family	3.86	5.56	6 55	5.34
Per adult male equivalent	1.82	2.17	2.43	2.17
Stamps and stationery:				
Per family	5.14	4.21	4.38	4.55
Per adult male equivalent	2.42	1 65	1 62	1.85
Traveling:				
Per family	34.79	33.32	49.55	38.90
Per adult male equivalent	16.39	13.04	18.35	15.78
War relief:				
Per family	6.83	7.76	10.83	8.43
Per adult male equivalent	3.22	3.04	4.01	3.42
Other expenses:				
Per family	0 45	2.94	0.86	1.50
Per adult male equivalent	0.21	1.15	0.32	0.61

Automobiles

Of the families visited, 22 owned automobiles. Eight different makes of cars were represented, in the following numbers: 9 Fords, 6 Overlands, 2 Chevrolets, 1 Buick, 1 Saxon, 1 Hupmobile, 1 Cadillac, and 1 Maxwell. The average cost per family having an automobile was $172.14. When all families were considered, the average cost for automobile use was $29.15 cash and $12.01 depreciation, making a total cost of $41.16 per family. The cost per adult male equivalent was $16.70.

Books, papers, and magazines

All expenses for general reading material for the family are included under one classification. Schoolbooks for the children, however, and other

books purchased primarily for educational purposes, are included under the heading "Educational."

Car fare

The principal costs falling under "Car fare," for the families studied, were those incurred by persons who used the Corona Company's motor busses for transportation to and from their work. When all families were considered, this cost was, of course, very small.

Charity

The average amount given to charity by these families was \$7.70 per family, or \$3.12 per adult male equivalent.

Church

Groton is generously supplied with churches, five denominations being represented. Undoubtedly the churches could do more effective work if some practicable method of uniting them could be developed. However, most of the families visited were giving financial aid to one of the churches. The average for all families was \$20.82 per family, or \$8.45 per adult male equivalent.

Clothing

Clothing is by far the most important expense included in the miscellaneous group. The average annual expenditure for clothing for all families was \$176.10 per family, or \$71.45 per adult male equivalent. The clothing cost per family increased with the total family income.

Doctors, dentists, and medicine

It cost the families \$70.79, on an average, for care of health for the year. This amounted to \$28.72 per adult male equivalent.

Domestic help

Only 18 of the 92 families hired any domestic help during the year. The average time given by hired domestic assistants was five days per family for all families. The cost of these five days of labor averaged \$7.42 per family, or \$3.01 per adult male equivalent.

Educational

The principal expenditures for education were those for books and other supplies for the school children, and the college expenses of one of the sons. In addition, several of the husbands were taking correspondence courses of various kinds to help them to become more efficient in their work. The average cost for educational purposes was \$15.79 per family, or \$6.41 per adult male equivalent.

Entertainment

The costs listed under "Entertainment" covered local entertainment primarily, such as the moving picture shows, and baseball and other games. Entertainment furnished in places other than Groton was included under "Traveling," since it seemed easier to get estimates of the entire cost of trips taken than to attempt to divide the cost among the various items of

expenditure. The average annual amount spent for local entertainment was \$27.72 per family, or \$11.25 per adult male equivalent.

Furniture

An average of \$47.16 per family, or \$19.13 per adult male equivalent, was spent for furniture during the year.

Furniture insurance

Of the 92 families, 59 carried insurance on their household goods. The average cost of this insurance for the year was \$1.57 per family for all families, or 64 cents per adult male equivalent.

House supplies

" House supplies " covers all articles necessary to equip a home which would not be classed as furniture. The average expenditure for house supplies amounted to \$18.57 per family, or \$7.53 per adult male equivalent.

Laundry

Most of the ordinary family laundry in the homes visited was done by the housewives. The average cost for laundry work done out of the home was \$22.09 per family, or \$8.96 per adult male equivalent.

Life insurance

Some life insurance was carried by one or more members of 74 of the 92 families. The average premium amounted to \$38.83 per family for all families, or \$15.75 per adult male equivalent. This cost is here considered as an expense, though it might be viewed as a part of the savings.

Organization dues

Approximately 74 per cent of the families visited included at least one member who belonged to some lodge, club, or society. The men in most of these families were members of the Corona Club. The average annual dues paid to these fraternal organizations amounted to \$5.34 per family, or \$2.17 per adult male equivalent, for all families.

Stamps and stationery

Stamps and stationery constitute a small item of expense. The average amount expended during the year for this purpose was \$4.55 per family, or \$1.85 per adult male equivalent.

Traveling

The annual cost for traveling amounted to \$38.90 per family, or \$15.78 per adult male equivalent.

War relief

The year covered by this survey was one of very active work by war relief organizations, especially the Red Cross and the Tompkins County War Chest Association. The average amount contributed for war relief was \$8.43 per family, or \$3.42 per adult male equivalent.

Other expenses

Records of a few lesser expenses were also obtained, but they were not deemed sufficiently important to tabulate separately since they were not

complete for all families. These expenses averaged $1.50 per family, or 61 cents per adult male equivalent, for the year.

Farm and garden costs

Of the families visited, 13 lived on small farms in the vicinity of Groton, and 62 of the families living in Groton had gardens or kept some sort of livestock, usually poultry. The average annual expenses incurred in operating these farms and gardens and taking care of the livestock are summarized in table 13:

TABLE 13. AVERAGE ANNUAL EXPENSES FOR FARMS, GARDENS, OR LIVESTOCK

(92 families, Groton, New York)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	29	34	29	92
Average family income	$1,398 44	$1,904 00	$2,756.66	$2,013.43
Adult male equivalent	2 17	2.83	3.52	2.84
Average expenses for all households:				
Cash per household	$63.07	$58.56	$100 86	$73 32
Not cash per household	35.34	17.41	26 83	26.03
Total:				
Per household	$98 41	$75.97	$127.69	$99.35
Per adult male equivalent	$45 40	$26 80	$36 29	$34 98

The details of these farm and garden expenses are given later, in connection with the comparative study of the families living on farms, those living in town and cultivating gardens or keeping livestock, and those living in town and not having gardens or livestock. It suffices here to present the summary, indicating the division between "cash" and "not cash" expenses. The "not cash" expenses are comprised primarily of interest on the average investment in land, livestock, and farm and garden equipment. The average farm and garden expenses for the year

TABLE 14. AVERAGE ANNUAL VALUE OF HOME-PRODUCED FOOD FOR HOME CONSUMPTION

(92 families, Groton, New York)

Family income group	Number in group	Average family income	Adult male equivalent	Average value for all households: Per household	Per adult male equivalent
$1600 or less	29	$1,398.44	2.17	$ 68.66	$31.67
$1601 to $2000	34	1,904 00	2.83	75.12	26.50
Over $2000	29	2,756.66	3.52	114.28	32.48
All groups	92	2,013.43	2.84	85.42	30.08

were $99.35 per household, considering all households. The corresponding figure per adult male equivalent was $34.98.

The value of the food furnished the homes from their farms, gardens, and livestock is shown in table 14. The details concerning these products are given on pages 48 to 56.

The cost of this home-produced food for home consumption is included in the farm, garden, and livestock expenses (table 13). These products are, of course, a family receipt as well as a family expense, and are included under "not cash" in the statement of the total family income (table 5, page 12).

Summary of living costs

A summary of expenses for the 92 families is given by income groups in table 15. The average cost of living for the year studied amounted to $1659.30 per family, or $615.83 per adult male equivalent.

TABLE 15. SUMMARY OF EXPENSES
(92 families, Groton, New York)

Family income group	Number in group	Average family income	Average family expenses	
			Per family	Per adult male equivalent
$1600 or less	29	$1,398.44	$1,334.09	$614.95
$1601 to $2000	34	1,904.00	1,574.13	575.11
Over $2000	29	2,756 66	2,084 42	661 29
All groups	92	2,013.43	1,659.30	615.83

SUMMARY OF CASH RECEIPTS AND CASH EXPENSES

The cash receipts and cash expenses, per family and per adult male equivalent, are brought together in table 16. In each income group, the

TABLE 16. SUMMARY OF CASH RECEIPTS AND CASH EXPENSES, SHOWING THE AMOUNT AVAILABLE FOR SAVINGS AND THE AMOUNT ACTUALLY SAVED
(92 families, Groton, New York)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	29	34	29	92
Cash income per family	$1,300.65	$1,800.06	$2,587.14	$1,890.75
Cash expenses per family	1,226 62	1,535 99	1,995.70	1,583.35
Amount available for savings	74 03	264.07	591 44	307.40
Amount actually saved:				
Per family	124 93	184 12	440 21	246.18
Per adult male equivalent	58.85	72.03	163.06	99.88
Per cent of income saved	9.6	10.2	17.0	13.0

difference between the receipts and the expenses gives the amount available for savings.

In order to check the accuracy of the estimates given, each family was questioned as to the amount of the year's income actually saved. Most persons seemed less inclined to give careful estimates of their savings than of any other item. In 77 of the 92 families, however, estimates as to savings were obtained. In the other 15 families, either the person questioned was unable to make a satisfactory estimate as to savings, or there was a definite refusal to answer the query. It is believed, therefore, that the averages given for actual savings are conservative.

The average amount available for savings for all families came to \$307.40 per family. The amount actually saved was \$246.18 per family. This would indicate that there was a discrepancy in the estimates for either the receipts or the expenses, of about \$61 per family. Of course the error is more likely to be found in the expenses, for it is extremely difficult to cover all miscellaneous expense items in a work of this nature.

By a comparative study by income groups of the amount of money available for savings and the amount of money actually saved, it is seen that in only one income group was the available-for-savings figure lower than that for the amount actually saved. It would seem, therefore, that the expense items were conservatively estimated.

The percentage of the total cash income actually saved is also given in table 16. The percentage of the total cash income saved increased with the family income. The 92 families saved 13 per cent of the cash income received.

COMPARISON OF RESULTS OBTAINED IN GROTON WITH RESULTS OF OTHER COST-OF-LIVING STUDIES

There have been countless cost-of-living studies made by different individuals and organizations throughout the world from time to time. A brief description of some of the most noteworthy of these is given below, in chronological order.

Sir Frederick Eden (1797) used the survey method in 1796 and collected data from 73 English families. The reason which he gave for making the investigation was as follows:

> The difficulties, which the labouring classes experienced, from the high price of grain, and of provisions in general, as well as of cloathing and fuel, during the years 1794 and 1795, induced me, from motives both of benevolence and personal curiosity, to investigate their condition in various parts of the kingdom.

It should be kept in mind, therefore, that Eden was working with a selected class of people — the poorest families of working people that he could find in England. Furthermore, his purpose in collecting these workingmen's budgets was rather to furnish him with facts concerning the condition of the poor, in order that he might pursue more intelligently his fight for the correction of the English poor laws, than to make a scientific study of the budgets themselves.

The next important study of workingmen's budgets was that made by Dr. Ernst Engel (1895). His method was the family-account system. Intelligent workingmen's families were persuaded to keep an exact account of all sources of family income and all family expenditures for at least one year in a book provided for the purpose. Engel's principal work is based

on data collected for the year 1853 from an unknown number of Belgian workingmen's budgets. On the basis of these Belgian budgets and other observations, Engel constructed a table, of which the following is an adaptation:

Item of expenditure	Per cent of the expenditures of a					
	Laboring family		Middle-class family		Well-to-to family	
Subsistence	62.0	95.0	55.0	90.0	50.0	85.0
Clothing	16.0		18.0		18.0	
Lodging	12.0		12.0		12.0	
Firing and lighting	5.0		5.0		5.0	
Education, public worship, and the like	2.0	5.0	3.5	10.0	5.5	15.0
Legal protection	1.0		2.0		3.0	
Care of health	1.0		2.0		3.0	
Comfort, mental and bodily recreation	1.0		2.5		3.5	

From this table Engel propounded what is known as Engel's Law, the points of which, as given by Wright (1889 250), are:

One. That the greater the income, the smaller the relative percentage of outlay for subsistence.

Two. That the percentage of outlay for clothing is approximately the same, whatever the income.

Three. That the percentage of outlay for lodging, or rent, and for fuel and light, is invariably the same, whatever the income.

Four. That as the income increases in amount, the percentage of outlay for "sundries" becomes greater.

A much more intensive method for studying family living conditions and living costs is the monographic method of LePlay, which consists of a detailed study of a workingman's family by a tactful investigator who will live with or near the family to be studied until he is thoroughly acquainted with all the circumstances. This method requires a great amount of time and energy. It was introduced by LePlay in 1829, and between that date and the year 1888 LePlay and fifty-seven of his followers made monographic studies of one hundred families in fifteen different countries. The results of their research were published by Cheysson and Toqué (1890).

The most extensive cost-of living investigations conducted in any country thus far are those made by the United States Department of Labor by the survey method. The results of the survey made in 1890–91 are given in the seventh annual report of the United States Commissioner of Labor (1892). This work includes the data from 2562 workingmen's budgets. The latest work of the Department of Labor in cost-of-living studies was done in 1918–19. It embodies data from the budgets of 12,096 families in ninety-two cities or localities of forty-two States. These families were selected to meet the following requirements (U. S. Labor Department, 1919 a: 147):

1. The family must be that of a wage earner or salaried worker, but not of a person in business for himself. The families taken should represent proportionally the wage earners and the low or medium salaried families of the locality. 2. The family must have as a minimum a husband and wife and at least one child who is not a boarder or

lodger. 3. The family must have kept house in the locality for the entire year covered. 4. At least 75 per cent of the family income must come from the principal breadwinner or others who contribute all earnings to family fund. 5. All items of income or expenditure of members other than those living as lodgers must be obtainable. 6. The family may not have boarders nor over three lodgers either outsiders or children living as such. 7. The family must have no subrental other than furnished rooms for lodgers. 8. Slum or charity families or non-English speaking families who have been less than five years in the United States should not be taken.

The results of this investigation are summarized in the *Monthly Labor Review* for May June, July, and August, 1919 (U. S. Labor Department, 1919, a, b, c, and d).

No attempt is made herein to show a money comparison of either receipts or expenses of the families included in the above-mentioned investigations, with the Groton families. The long period of time over which those studies extended, and the wide geographical distribution of the families studied, would make a money comparison unsatisfactory. It will suffice to say that the workingman's family income has increased rapidly, not only in dollars and cents but also in the quantity of commodities which it will purchase, from the time of Sir Frederick Eden to the present. The only comparison which can be made profitably is that of the percentage of the total family income expended for the principal groups of living costs. All of the cost-of-living investigations described have been presented in such a manner that the following groups of living costs can be separated: food, rent, clothing, fuel and light, and all other purposes. A comparison of percentages of the total family expenditures for these different groups of living costs is presented in table 17.

O course no close comparison should be made of data covering such a long period of time and of such wide geographical distribution. The relative prices for the various groups of living expenses differ from year to year, and the prices for a particular group of commodities, such as food, vary widely in different countries at the same date. However, the first and fourth points in Engel's law (page 28 do seem to be established in

TABLE 17. COMPARISON OF PERCENTAGES OF THE TOTAL FAMILY EXPENDITURES FOR THE DIFFERENT GROUPS OF LIVING COSTS

Item of expenditure	Eden's 73 English budgets, 1796*	Engel's Belgian budgets, 1853†	LePlay Method, 100 budgets, 1829–1888‡	U. S. Dept. Labor, 2562 budgets, 1890–91§	U. S. Dept. Labor, 12,096 budgets, 1918–19‖	Groton, New York, 92 budgets, 1919
Food	73.0	66.9	56.8	41.1	38.2	41.7**
Rent	12.0	7.6	6.8	15.1	13.4¶	13.1
Clothing	7.0	14.9	16.5	15.3	16.6	11.3
Fuel and light	5.0	5.6	4.3	5.9	5.3¶	6.8
All other purposes	3.0	5.0	15.6	22.7	26.4	27.1

* Eden, Sir Frederick Morton. The state of the poor, vol. 3, 1797, Appendix 12 (calculated).
† Engel, Ernst. Die Lebenskosten belgischer Arbeiter-Familien früher und jetzt. Bul. de l'Institut Internat. de Statistique, vol. 9, 1895, p. 42.
‡ Cheysson, E., and Toqué, Alfred. Les budgets comparés des cent monographies de familles. Bul. de l'Institut Internat. de Statisque, vol. 5, 1890, p. 108–157 (calculated).
§ U. S. Commissioner of Labor, Seventh Annual Report, 1891, p. 864.
‖ U. S. Department of Labor, Monthly Labor Review, vol. 9, August, 1919, p. 118.
¶ Not including 295 families in which rent is combined with fuel and light.
** Including purchased food, and value of home-grown food for home consumption.

ble 17. The proportion of the total family income necessary to defray e expenses for food decreased perceptibly in each investigation from the ne of Sir Frederick Eden's work in 1796 to that of the United States partment of Labor in 1918–19. The percentage of the income spent for od was slightly higher for the Groton families than for the United States partment of Labor budgets. As Engel contended, this decreasing per-ntage of the income spent for food can be taken as an indication of terial well-being; for the average income of workingmen's families has reased rapidly with each succeeding investigation here mentioned, ce that made by Sir Frederick Eden. As to the truth of the fourth nt in Engel's law, that the percentage of the outlay for "sundries" comes greater with an increase in income, there can be no question. e increase is from 3 per cent for Eden's work to 27.1 per cent for the oton families. The percentages given in the table for rent, clothing, l fuel and light, are not for purposes of comparison. The differences customs and habits of life for the various countries and for the various iods probably more than offset any differences to be found in the figures these three classes of costs.

he second and third propositions of Engel's law, that the percentage of lay for clothing, rent, and heat and light is approximately the same atever the income, are not so well established. Even in his own work n the Belgian budgets Engel found that the percentage of outlay for hing increased from 10.9 in families with an income under 600 francs, 7.1 in families with an income exceeding 2000 francs. In the same work e was a perceptible decrease in the percentage of outlay for fuel and t as the income increased. In the 1890–91 data of the United States artment of Labor, the tendency for the percentage of outlay for ning to increase and that for fuel and light to decrease with an increase ne amily income was very noticeable. In the later work of the United es Department of Labor, the same tendencies prevailed for clothing nses and for fuel and light costs as in the work of 1890–91; also, the entage of outlay for rent decreased with an increase in income.

ne average percentage of expenditure for food, clothing, upkeep or fuel and light, and all other purposes, for 87 of the Groton families, ven by income groups in table 18. In the preparation of this table

E 18. AVERAGE PERCENTAGE OF EXPENDITURE PER ANNUM FOR THE PRINCIPAL ROUPS OF ITEMS OF COST OF LIVING OF 87 FAMILIES IN GROTON, NEW YORK

y income group	$1600 or less	$1601 to $2000	Over $2000	All groups
er in group	34	32	21	87
ge family income	$1,429 21	$1,821 12	$2,740 76	$1,889 94
ge per cent of yearly expenditure per family for:				
od*	41.7	42.7	40.5	41.7
othing	10.1	11.2	12.7	11.3
ent or upkeep	14.7	12.1	12.5	13.1
el and light	7.5	6.8	6.1	6.8
l other purposes	26.0	27.2	28.2	27.1

ding purchased food, and value of home-grown food for home consumption.

it was thought desirable, in order to make a more adequate comparison with the results of other investigations, to eliminate the five families who boarded for the entire year. Of the 87 families remaining, 21 had taken into the home one or more boarders for varying periods during the year. It was deemed desirable to eliminate also, as far as possible, the influence of these boarders on the results. Therefore the income from boarders and roomers was omitted from the total family income, necessitating a reclassification of families by income groups. Thus, the expense for all food was decreased by the percentage which the adult male equivalent of boarders represented of the total adult male equivalent for the households. The total family expenses were reduced by the same amount. Of course the food cost is not the only cost involved in keeping boarders, but it is by far the most important one and the only one that could be deducted with any degree of accuracy.

There were too few of the Groton budgets to permit making a detailed study of the influence of increasing income on the ways in which the income was spent. The tendency was, however, for the percentage of outlay for food, rent or upkeep, and fuel and light, to decrease, and that for clothing and all other purposes to increase, with increasing family income.

The data for 518 families in New York City are given in table 19. The New York figures are for approximately the year preceding those for Groton. The average family income for the New York families was \$1556.33, and that for the 87 Groton families approximately one year later was \$1889.94, omitting receipts from boarders and roomers. The average weekly earnings of factory employees in New York City increased about 33 per cent from December of 1917 to December of 1918 (U. S. Labor

TABLE 19. AVERAGE PERCENTAGE OF EXPENDITURE PER ANNUM FOR THE PRINCIPAL GROUPS OF ITEMS OF COST OF LIVING OF 518 FAMILIES IN NEW YORK CITY, BY INCOME GROUPS*

Income group	Number of families	Average yearly per cent of expenditures per family for				
		Food	Clothing	Rent	Fuel and light	All other purposes
Under \$900	16	45.7	10.2	20.0†	5.7†	18.0
\$900-\$1199.99	107	46.0	13.8	16.0‡	5.2‡	18.5
\$1200-\$1499.99	151	43.5	14.9	15.4§	4.4§	20.7
\$1500-\$1799.99	115	40.9	17.5	14.1‖	4.3‖	22.2
\$1800-\$2099.99	66	41.1	17.3	12.3¶	3.8¶	23.2
\$2100-\$2499.99	38	38.5	19.3	12.0‡	3.8‡	26.2
\$2500 and over	25	38.8	21.0	12.3**	3.1**	24.8
All groups	518	42.0	16.6	14.3††	4.3††	22.0

* United States Bureau of Labor Statistics, Monthly Labor Review, vol. 8, May, 1919, p. 158.
† Not including 1 family in which rent is combined with fuel and light.
‡ Not including 11 families in which rent is combined with fuel and light.
§ Not including 34 families in which rent is combined with fuel and light.
‖ Not including 25 families in which rent is combined with fuel and light.
¶ Not including 23 families in which rent is combined with fuel and light.
** Not including 5 families in which rent is combined with fuel and light.
†† Not including 110 families in which rent is combined with fuel and light.

Dept., 1920 b: 110). In all probability, therefore, the average income for the New York families equaled or exceeded that for the Groton families in 1919. On the other hand, from the data available (U. S. Labor Dept., 1920 a: 84, 86) it would seem that the cost of living in New York City did not increase so rapidly as did wages during the period mentioned above, although it would seem that the difference between the rise of wages and the rise of living costs would not be great enough during the year under consideration to make any appreciable changes in the results for New York given in table 19. A direct comparison of the New York figures with those from Groton seems logical.

The general tendency for the percentage of the total family income expended for food, rent, and fuel and light to decrease, and that for clothing and all other purposes to increase, with an increase in the income, seems to be the same for the New York and the Groton families. When the averages for all families are compared, the principal differences seem to be in the percentage expended for clothing and all other purposes. The Groton families spent approximately 5 per cent less of their incomes for clothing than did the New York families.

Perhaps the best measure for comparing the New York families with the Groton families as to general well-being is the amount saved per family. The average surplus per family for the New York families was $30.67 (U. S. Labor Dept., 1919 a: 158). The average amount actually saved per family in Groton was $246.18 (table 16, page 26). Even with a 33-percent increase in earnings for the New York families, they could hardly hope to save as much as did the families in the small town.

COMPARISON OF LIVING CONDITIONS AND LIVING COSTS OF PERSONS EMPLOYED IN A FACTORY, AND LIVING ON FARMS, LIVING IN TOWN AND CULTIVATING GARDENS OR KEEPING LIVESTOCK, AND LIVING IN TOWN WITH NO GARDENS NOR LIVESTOCK

Before beginning a comparison of living costs of factory employees under various conditions, it is thought advantageous to give an idea as to the farm experience of the husbands and wives in the households studied. Data for this are presented in table 20:

TABLE 20. FARM EXPERIENCE OF THE HEADS OF 92 HOUSEHOLDS, GROTON, NEW YORK

Period spend on farms	Husbands		Wives	
	Number	Per cent	Number	Per cent
Born on farms	39	42.9	32	34.8
Moved to farms before 21 years old	6	6.6	10	10.9
Left farms at 21 years of age or older	27	29.7	21	22.8
Always lived on farms	1	1.1	4	4.3
On farms at time of study	12*	13.2	13*	14.1
Lived on farms at some time	56	61.5	49	53.3
Never lived on farms	35	38.5	43	46.7

* One husband boarded in town, while his wife lived on the farm.

Approximately 43 per cent of the husbands and 35 per cent of the wives were born on farms. In addition, about 7 per cent of the husbands and 11 per cent of the wives moved to farms with their parents before they were twenty-one years of age. Hence, approximately 50 per cent of the husbands and 46 per cent of the wives were farm-reared. Still others among the parents, however, had lived on farms at some period during their lives. A total of 61.5 per cent of the husbands and 53.3 per cent of the wives had at some time lived on a farm.

SIZE OF IMMEDIATE FAMILY

The immediate families (husband, wife, and children) averaged slightly larger for the families living on farms. The average adult male equivalent per immediate family at home was 2.84 for all families. The corresponding figure for the families living on farms was 3.22. (Table 21.)

TABLE 21. COMPARISON OF AVERAGE SIZE OF IMMEDIATE FAMILY, BY HOME CLASSIFICATIONS

(92 families, Groton, New York)

Home classification	Number in class	Size of immediate family			Adult male equivalent at home
		At home	Not at home	Total	
Farm	13	3.9	0.3	4.2	3.22
Garden or livestock	62	3.3	0.3	3.6	2.79
No garden nor livestock	17	2.8	0.5	3.3	2.75
All families	92	3.3	0.3	3.6	2.84

It is seen in table 21 that there were 13 families included in the farm classification. Two of these families, however, had nothing to do with the operation of the farms on which they lived. They merely occupied the houses and had garden plots. One of these families kept a flock of chickens and two cows. The other family had no livestock. These two families are included in the farm classification in the comparisons of the expenses for upkeep or rent, light, heat, water, and telephone. In all other comparisons, however, they are included in the garden or livestock classification.

FAMILY INCOME

A comparison of the average family income from all sources for the families living on farms, living in town and cultivating gardens or keeping livestock, and living in town with no gardens nor livestock, is shown in table 22. The average family income from all sources was considerably the highest for the families living on farms. However, this comparison is made of gross income, and it should be noted that almost half of the receipts of the farm families came from the wives and from farm produce. In table 5 (page 12) it was shown that approximately one-half of the amount

TABLE 22. COMPARISON OF AVERAGE FAMILY INCOME FROM ALL SOURCES, BY HOME CLASSIFICATIONS

(92 families, Groton, New York)

Home classification	Farm	Garden or livestock	No garden nor livestock	All families
Number in class	11	64	17	92
Adult male equivalent	2.87	2.48	2.13	2.46
Average receipts from:				
Husband	$1,307 91	$1,571.53	$1,474.41	$1,522.07
Wife	547.18	211.23	351.76	277.37
Sons	91 18	31.02	48.59	41.46
Daughters	2.27	3.48	....	2.70
Other members of family	....	13 05	....	9.08
Farms, gardens, or livestock	718.27	107 62	....	160.75
Average family income from all sources:				
Per family	$2,666.81	$1,937.93	$1,874 76	$2,013.43
Per adult male equivalent	928.91	780.34	879 44	816.87

contributed by the wives was pay from roomers and boarders, a very small proportion of which is net income. After the costs, other than family labor, of producing the farm products are deducted, only $247.45 remains as pay for family labor. The net income of the farm families is undoubtedly smaller than that of the other two groups.

FAMILY EXPENSES

The average annual costs of upkeep or rent, light, heat, water, and telephone service, for the families living on farms, living in town and cultivating gardens or keeping livestock, and living in town with no gardens nor livestock, are compared in table 23.

Upkeep or rent

A comparison of both owned and rented homes of the families living on farms, living in town and cultivating gardens or keeping livestock, and living in town with no gardens nor livestock, is given in table 24. Of the 13 farm homes, 12 were owned by the occupants. Of the 74 homes in town, 32 were owned and 42 were rented. All of the families who occupied their own homes cultivated gardens or kept some livestock. Of the owned homes, those on the farms were slightly the larger, but the average value of buildings was about 31 per cent less than the average value of the buildings for the town homes. This difference in value of buildings was due partly to the fact that the town homes were of better construction, but the principal reason for the difference was location. Of the owned farm homes, 75 per cent were not equipped with bathrooms or inside toilets, as compared with about 6 per cent of the owned town homes not having these improvements.

Since there was but one rented farm home, the only fair comparison to be made is between the other two home classifications. The 30 rented

TABLE 23. COMPARISON OF AVERAGE ANNUAL COST OF UPKEEP OR RENT, LIGHT, HEAT, WATER, AND TELEPHONE, BY HOME CLASSIFICATIONS

(92 families, Groton, New York)

Home classification	Farm	Garden or livestock	No garden nor livestock	All families
Number in class	13	62	17	92
Adult male equivalent	3.72	2.77	2.26	2.81
Upkeep or rent:				
Per family	$180.31	$216.37	$158.88	$200 65
Per adult male equivalent	48.48	77.99	70.39	71.35
Light:				
Per family	15.85	17.74	11.41	16.30
Per adult male equivalent	4.26	6.40	5.06	5.80
Heat:				
Per family	88.38	90.92	56.47	84.19
Per adult male equivalent	23.76	32.77	25.02	29.94
Water:				
Per family	4.46	6 18	3 35	5.41
Per adult male equivalent	1 20	2.23	1.49	1.92
Telephone:				
Per family	8.23	2 69	3 00	3.53
Per adult male equivalent	2.21	0.97	1.33	1.26

homes having gardens or livestock averaged about one room larger than the 12 homes with no gardens nor livestock. Nearly three-fourths of the rented homes having gardens or livestock were equipped with bathrooms and inside toilets. Only one-half of the homes with no gardens nor livestock had bathrooms and inside toilets. The above-mentioned points explain to a large extent the difference in value of buildings between these two classes of homes.

TABLE 24. COMPARISON OF THE COST OF UPKEEP OR RENT, BY HOME CLASSIFICATIONS

(87 families, Groton, New York)

Home classification	Number in class	Average value of buildings	Average number of rooms	Per cent having: Neither bath nor toilet	Per cent having: Bath and toilet	Per cent having: Toilet only
			Owners			
Farm	12	$2,111.67	8.2	75.0	25.0	0
Garden or livestock	32	3,047.44	7.8	6.2	87.5	6.3
No garden nor livestock	......	....	.....	.....	.....	....
			Renters			
Farm	1	$1,300 00	8.0	100.0	0	0
Garden or livestock	30	2,253.50	6.2	13.3	73.4	13.3
No garden nor livestock	12	1,612.50	5.1	33.3	50.0	16.7

The upkeep or rent cost was lowest on the farms, where it averaged \$48.48 per adult male equivalent for the year (table 23). It was highest for the group of families in town who were cultivating gardens or keeping some kind of livestock. The figure per adult male equivalent for these families was \$77.99.

Light

A comparison of light cost by home classifications shows the smallest cost per family for those families having no gardens nor livestock. The cost per adult male equivalent, however, was lowest for the farm families. (Table 23.)

Electric lights were found in 76 per cent of the town homes, whereas all of the farm homes used kerosene for lighting with the exception of one home which had acetylene lights.

Heat

Furnaces were used in 67 per cent of the town homes and in 23 per cent of the farm homes. The average cost of all fuel for heating and cooking purposes per adult male equivalent was lowest for the farm families (table 23).

Water

Running water came from the town water-mains in 81.5 per cent of the town homes. Only 46 per cent of the farm homes had water piped into the house.

A comparison of the costs for water shows that the cost per family was lowest for the families living in town with no gardens nor livestock. Due to the larger size of the families on the farms, however, the cost per adult male equivalent was lowest for the farm families. (Table 23.)

Telephone

Telephones were found in a larger proportion of the farm homes than of the town homes (page 20). The cost per family for telephone service for all farm families averaged \$8.23. The average cost for the 92 families was \$3.53. (Table 23.)

TABLE 25. COMPARISON OF AVERAGE ANNUAL COST OF BOARD AND PURCHASED FOOD, BY HOME CLASSIFICATIONS

(92 households, Groton, New York)

Home classification	Number in class	Adult male equivalent	Average cost of board		Average cost of purchased food	
			Per household	Per adult male equivalent	Per household	Per adult male equivalent
Farm	11	4.37	\$ 16.27	\$ 3.73	\$818.18	\$187.38
Garden or livestock	64	2.75	20.36	7.41	652.27	237.55
No garden nor livestock	17	2.21	205.18	92.96	409.06	185.34
All families	92	2.84	54.02	19.02	627.16	220.83

Board

The cost of meals taken out of the home was very low for the farm families, averaging $16.27 for all farm households (table 25). The expense for board was, of course, highest in the families with no gardens nor livestock, since the five families who boarded all the year were included in this group.

Purchased food

The amount spent for purchased food was highest per household for the farm families (table 25). If the board and purchased-food costs were combined, however, the cost per adult male equivalent would be lowest for the farm families and highest for the families living in town with no gardens nor livestock.

Miscellaneous expenses

A comparison of the miscellaneous expenses of the families living on farms with those of the families living in town is shown in table 26:

TABLE 26. COMPARISON OF AVERAGE ANNUAL MISCELLANEOUS EXPENSES OF FAMILIES LIVING ON FARMS, AND OF THOSE LIVING IN TOWN

(92 families, Groton, New York)

Home classification	Farm	Town	All families
Number in class	11	81	92
Adult male equivalent	2.87	2.41	2.46
Automobiles:			
Per family	$ 31.18	$ 42 52	$ 41.16
Per adult male equivalent	10 86	17.64	16.70
Books, papers, and magazines:			
Per family	12.36	13.63	13.48
Per adult male equivalent	4.31	5.66	5.47
Car fare:			
Per family	1 73	0 64	0.77
Per adult male equivalent	0.60	0.27	0.31
Charity:			
Per family	4 55	8.12	7.70
Per adult male equivalent	1 58	3.37	3.12
Church:			
Per family	11.64	22.06	20.82
Per adult male equivalent	4.05	9.16	8 45
Clothing:			
Per family	152.73	179.27	176 10
Per adult male equivalent	53.19	74 40	71.45
Doctors, dentists, and medicine:			
Per family	42 55	74.63	70.79
Per adult male equivalent	14.82	30.97	28.72
Domestic help:			
Per family	26.82	4.79	7.42
Per adult male equivalent	9.34	1.99	3.01
Education:			
Per family	66.27	8.94	15.79
Per adult male equivalent	23.08	3.71	6.41
Entertainment:			
Per family	11.09	29.98	27.72
Per adult male equivalent	3.86	12.44	11.25
Furniture:			
Per family	66.55	44.53	47.16
Per adult male equivalent	23.18	18.48	19.13

TABLE 26 (*concluded*)

Home classification	Farm	Town	All families
Number in class	11	81	92
Adult male equivalent	2.87	2.41	2.46
Furniture insurance:			
Per family	$ 1.00	$ 1 64	$ 1 57
Per adult male equivalent	0.35	0 68	0.64
House supplies:			
Per family	12.09	19.44	18.57
Per adult male equivalent	4.21	8.07	7.53
Laundry:			
Per family	11 36	23.54	22.09
Per adult male equivalent	3 96	9.77	8 96
Life insurance:			
Per family	18 55	41.48	38.83
Per adult male equivalent	6 46	17.26	15.75
Organization dues:			
Per family	2 09	5.78	5.34
Per adult male equivalent	0.73	2.40	2.17
Stamps and stationery:			
Per family	3.00	4.77	4.55
Per adult male equivalent	1.04	1.98	1.85
Traveling:			
Per family	18.55	41.67	38.90
Per adult male equivalent	6.46	17.29	15.78
War relief:			
Per family	7.27	8.59	8.43
Per adult male equivalent	2.53	3.57	3.42
All other expenses:			
Per family	3.64	1.21	1.50
Per adult male equivalent	1.27	0.50	0.61

The percentage of the farm families owning automobiles was 27, as compared with 23 per cent of the town families. The farm families owned the less expensive cars, however, making the cost per family lower for that group.

The farm families spent less than did the families living in town for books, papers, and magazines, and for charitable and church purposes. Although the farm families were larger than the town families, the clothing cost per family was considerably less for the former, due probably to the fact that persons living on farms, have more opportunity to wear out their old clothes. The charges for doctor's services were also less for the farm families, in spite of the fact that for them the charge per visit was higher. The farm families spent much less for entertainment. A considerable proportion of their recreation was derived from performing productive farm work. The farm families spent less than did the town families for house supplies, for furniture insurance, for laundry, for organization dues, for stamps and stationery, and for traveling. The average farm family carried less life insurance than did the average family living in town. Car fare, which was primarily the charge for transportation on the Corona Company's motor busses, was higher for the farm families, of course. More money was spent by the farm families for educational purposes. The only son in college from the 92 families was from one of the farms. The cost of furni-

ture for the year was higher in the farm families, and they also paid more for domestic help than did the families living in town. However, one of the farm families had an average of fourteen boarders for the year, and $20.09 of the average of $26.82 per family was pay for domestic help in this one family. All families were about equally patriotic, as is indicated by the expenditures for war relief.

Farm and garden costs

The average expense for operating the 11 farms was $470.82 per farm, or $107.83 per adult male equivalent. The average garden and livestock expenses for the 64 families in town having these expenses were $61.89 per family, or $22.54 per adult male equivalent. These figures include all farm, garden, and livestock costs with the exception of the labor performed by members of the family.

Summary of expenses

All the expenses are combined, in table 27, for comparison by home classifications. The average expenses per family were largest in the farm families and smallest in the town families with no gardens nor livestock. When the averages are considered on the adult-male-equivalent basis, however, the order is exactly reversed.

TABLE 27. COMPARISON OF AVERAGE ANNUAL EXPENSES, BY HOME CLASSIFICATIONS

(92 families, Groton, New York)

Home classification	Number in class	Average family expense	
		Per family	Per adult male equivalent
Farm	11	$2,107.52	$554.73
Garden or livestock	64	1,637.86	617.15
No garden nor livestock	17	1,454.41	666.36
All families	92	1,659.30	615.83

SUMMARY OF CASH RECEIPTS AND CASH EXPENSES

A comparison of the annual cash receipts and cash expenses for the families living on farms, living in town and cultivating gardens or keeping livestock, and living in town with no gardens nor livestock, is presented in table 28. The amount of cash actually saved was lowest for the farm families and highest for the town families with no gardens nor livestock. However, 91 per cent of the farm families owned their homes, in which they had an average investment of $2950 per family when all farm families are considered. On the other hand, none of the families living in town with no gardens nor livestock owned the homes in which they lived. Of the families living in town and cultivating gardens or keeping livestock, 53 per cent owned their homes. This gives an average investment in homes of approximately $1896 for the 64 families in that group.

TABLE 28. COMPARISON OF ANNUAL CASH RECEIPTS AND CASH EXPENSES, BY HOME CLASSIFICATIONS, SHOWING THE AMOUNT AVAILABLE FOR SAVINGS AND THE AMOUNT ACTUALLY SAVED

(92 families, Groton, New York)

Home classification	Number in class	Cash income per family	Cash expenses per family	Available for savings per family	Actually saved: Per family	Actually saved: Per adult male equivalent	Per cent of cash income saved
Farm	11	$2,265 55	$1,904 00	$361 55	$221 82	$ 77.26	9.8
Garden or livestock	64	1,845.48	1,579 78	265.70	232.28	93.53	12.6
No garden nor livestock	17	1,818 59	1,389.41	429 18	314.29	147.43	17.3
All families	92	1,890.75	1,583 35	307.40	246.18	99 88	13.0

DETAILS OF FARMS, GARDENS, AND LIVESTOCK

Up to this point, only summaries of receipts and expenses for farms, gardens, and livestock have been given The details of these receipts and expenses follow.

LIVESTOCK

The average quantity and value of the different classes of livestock produced for home use are presented in table 29:

TABLE 29. AVERAGE ANNUAL QUANTITY AND VALUE OF LIVESTOCK PRODUCED FOR HOME USE, BY HOME CLASSIFICATIONS

(75 families, Groton, New York)

Home classification	Farm		Garden or livestock	
Number in class	11		64	
Kind of livestock	Average per family producing	Average for all families	Average per family producing	Average for all families
Veal:				
Pounds	250.0	22.7	....	....
Value	$45 00	$4 09	....	....
Pork:				
Pounds	193.3	105.5	219.0	17.1
Value	$47 67	$26.00	$54 60	$4.27
Poultry:				
Number	17.1	14.0	18.7	4.4
Value	$20 11	$16.45	$23 67	$5.55
Rabbits:				
Pounds	18 0	1.6	....	....
Value	$3 00	$0.27	....	....
Average value	$51.50	$46.81	$39.25	$9.82

Hogs and poultry were the principal classes of livestock raised for home consumption. The farm families producing pork furnished 193.3 pounds per family for home use, valued at $47.67. A few hogs were raised in town also for home use, the average being 219 pounds, valued at $54.60, for the few town families who produced pork. An average of 17.1 chickens and ducks, valued at $20.11, were used in the homes of the farm families who raised poultry. The town families who raised poultry used an average of 18.7 chickens, worth $23.67. One farm family butchered a veal calf for home use, while another used a few Belgian hares.

The average value of all meat produced for home use by the farm families was $51.50 per family producing, or $46.81 per family for the 11 farm families. The value of the meat produced for home consumption by the town families averaged $39.25 per family producing, or $9.82 for all families.

The average receipts from sale of livestock for the farm families was $167 per family selling, or $136.63 for all farm families (table 30). A small amount of livestock was sold by a few of the town families.

TABLE 30. AVERAGE ANNUAL RECEIPTS FROM SALE OF LIVESTOCK, BY HOME CLASSIFICATIONS

(75 families, Groton, New York)

Home classification	Farm		Garden or livestock	
Number in class	11		64	
Kind of livestock	Average per family selling	Average for all families	Average per family selling	Average for all families
Dairy cows	$212.00	$ 77.09	....	....
Heifer calves	42.50	15.45	....	....
Veal calves	46.00	8.36	$ 8.00	$0.12
Horses	150 00	13.64	....	....
Brood sows	70 00	6 36	....	....
Other hogs	60 50	11.00	75.00	1.17
Poultry	13 00	4.73	19.89	2.80
Average	$167.00	$136 63	$29.11	$4.09

Details of the expenses for livestock purchased are given in table 31. The average expense for the purchase of livestock was $101.60 for the farm families purchasing, and $17.57 for the families in town who bought any livestock.

LIVESTOCK PRODUCTS

The livestock products for home use consisted of whole milk, butter, and eggs. The average quantity and value of these products for the families producing them, and for all families in each home classification, are given in table 32. The average value of all livestock products per farm family producing them for home use was $145.10, or $131.91 for all farm families. The average value of all livestock products used in the town homes producing them was $48.55, or $15.17 for the 64 families. Only 2 of the town families kept cows, and only 25 raised poultry.

TABLE 31. AVERAGE ANNUAL EXPENSE FOR LIVESTOCK PURCHASED, BY HOME CLASSIFICATIONS

(75 families, Groton, New York)

Home classification	Farm		Garden or livestock	
Number in class	11		64	
Kind of livestock	Average per family purchasing	Average for all families	Average per family purchasing	Average for all families
Dairy cows	$131 20	$59 64	$100 00	$1 56
Heifer calves	21 50	3 91	....	....
Veal calves	4 50	0 82	....	....
Horses	125 00	11 36	....	....
Pigs	13 33	10.91	10 80	0.84
Chickens	6 67	3 64	9.20	1.44
Baby chicks	20 00	1.82	....	....
Rabbits	3.00	0 27	....	....
Average	$101 60	$92.37	$17.57	$3 84

TABLE 32. AVERAGE ANNUAL QUANTITY AND VALUE OF LIVESTOCK PRODUCTS PRODUCED FOR HOME USE, BY HOME CLASSIFICATIONS

(75 families, Groton, New York)

Home classification	Farm		Garden or livestock	
Number in class	11		64	
Kind of product	Average per family producing	Average for all families	Average per family producing	Average for all families
Whole milk:				
Quarts	682.4	558.4	730.0	22.8
Value	$70 78	$57.91	$85 50	$2.67
Butter:				
Pounds	68.0	30.9	104.0	1.6
Value	$36 60	$16 64	$57.00	$0 89
Eggs:				
Dozen	126.3	114.8	70.7	22.1
Value	$63.10	$57.36	$37.15	$11.61
Average value	$145 10	$131.91	$48.55	$15.17

The receipts from the sale of livestock products averaged $156.37 per family for all farm families, and $14.10 per family for the 64 town families (table 33). The receipts from this source per family selling these products averaged $286.67 for the farm families and $75.17 for the town families.

In addition to the livestock products used in the homes and those sold, whole milk, skimmilk, and buttermilk valued at $120 was fed to livestock. This amount is not included here as either a receipt or an expense.

TABLE 33. AVERAGE ANNUAL QUANTITY AND VALUE OF LIVESTOCK PRODUCTS SOLD, BY HOME CLASSIFICATIONS

(75 families, Groton, New York)

Home classification	Farm		Garden or livestock	
Number in class	11		64	
Kind of product	Average per family selling products	Average for all families	Average per family selling products	Average for all families
Whole milk:				
Quarts	3,407 4	1,548.8	2,966.0	92.7
Value	$304.80	$138.55	$327.00	$10.22
Butter:				
Pounds	30.0	2.7	....	....
Value	$18.00	$1.64	....	....
Eggs:				
Dozen	112.7	30.7	52.1	7.3
Value	$58.00	$15.82	$27.00	$3.80
Hides:				
Number	4.0	0.4	1.0	0.02
Value	$4 00	$0.36	$5 00	$0.08
Average value	$286.67	$156.37	$75.17	$14.10

CROPS

The value of the crops sold and those produced for home consumption, for the families producing them and for all families in the two home classifications, is shown in table 34. Very few crops were raised for sale by these families. The average receipts from the sale of crops on the 11 farms were $31.28 per farm, or $49.14 per farm family selling any crops. The average receipts from the sale of garden produce for the town families selling were $13 08 per family. Vegetables formed the most important class of crops raised, and most of these were used by the families raising them.

The farm families fed to their livestock crops totaling $1748 in value, or an average of $158.91 per farm. This amount is not here considered in either the receipts or the expenses. The town families fed no home-raised crops of value to their livestock.

MISCELLANEOUS RECEIPTS

On 7 of the farms the value of land, equipment, livestock, and feed and supplies, was greater at the end of the year covered by the survey than at the beginning of the year. This increase in capital amounted to $1057 and was considered as a receipt. One of the farm families received $10 from a neighbor for pasturing a cow; another made two gallons of maple sirup and ten pounds of maple sugar for home use, which together were valued at $6.

There was an increase of $695 invested in land, garden tools, and livestock, in 23 of the 64 town homes having gardens or livestock. One of

these families sold a town lot and some garden tools for $202; three families rented their barns as garages, from which they received $78; and one other family made five gallons of maple sirup for home use, valued at $6.

TABLE 34. AVERAGE ANNUAL VALUE OF CROPS SOLD AND PRODUCED FOR HOME USE, BY HOME CLASSIFICATIONS

(75 families, Groton, New York)

Home classification	Farm		Garden or livestock	
Number in class	11		64	
Kind of crop	Average per family producing	Average for all families	Average per family producing	Average for all families
Corn:				
Sold	$ 3.00	$ 0.27	....	....
Used at home	6 00	0 55	....	....
Buckwheat:				
Used at home	7 00	0.64	....	....
Oats:				
Sold	50 00	4 55	$25.00	$ 0.39
Wheat:				
Sold	....	......	25.00	0 39
Hay:				
Sold	56 50	10.27	....	....
Fruits:				
Sold	31 00	5.64	7 00	0.22
Used at home	16 89	13 82	11.38	2.31
Vegetables:				
Sold	23.20	10 55	13 29	1.45
Used at home	102.73	102.73	47.32	44.36
Total:				
Sold	49.14	31.28	13.08	2.45
Used at home	117.74	117.74	48.18	46.67

MISCELLANEOUS EXPENSES

Any decrease in the capital invested in land, equipment, livestock, and feed and supplies, was considered as an expense. The decrease in capital for 4 of the farm families amounted to $345, and for 10 of the town families it was $492.

Interest was charged at 6 per cent on the average investment for the year in land, equipment, livestock, and feed and supplies. This amounted to $802 for all the 11 farm families, or $72.91 per family. For the 46 town families reporting any investment in land, garden tools, or livestock, the total interest charge was $846, or $18.39 per family.

Details of all other farm, garden, or livestock expenses are given by home classifications in table 35. The largest two items of expense for the farm families were for purchased feed for livestock, and day labor, in the order named. All of these families purchased some feed, the average being $164.55 per family. The day-labor expense covers both man and horse labor. Approximately one-fourth of the labor expense was for horse hire. Seven of the farm families did not own a horse, and the other four

families owned but one each. Two of these four horses were used for driving to the factory and were not available for much farm labor. Horse labor seemed to be one of the most serious problems on these small farms.

TABLE 35. AVERAGE ANNUAL MISCELLANEOUS FARM, GARDEN, OR LIVESTOCK EXPENSES

(75 families, Groton, New York)

Home classification	Farm		Garden or livestock	
Number in class	11		64	
Items of expense	Average per family having expense	Average for all families	Average per family having expense	Average for all families
Day labor	$ 36.78	$ 36.78	....	....
Board of day labor	2.00	0.18	....	....
Barrels and baskets	1 50	0.27	....	....
Breeding fees	2.00	0.18	....	....
Cash rent of land	12 50	2.27	$ 4 50	$ 0.23
Feed	164 55	164.55	57.46	23 34
Feed grinding	2 00	0 18	....	....
Fencing	8 17	4.45	15.33	1.44
Fertilizer	13 00	7.09	1 83	0 17
Lime	....	....	1.50	0 05
Manure	....	....	3.50	0.93
Horse shoeing	16 80	7 64	13.00	0.20
Equipment purchased	34 00	9 27	5 25	0.82
Equipment repaired	20 00	1 82	15 00	0 23
Threshing	4 00	0 36	2 00	0.03
Milk hauling	8 50	1.55	....	....
Milk utensils	2.00	0.18	3.00	0 05
Seed, plants, and trees	25 27	25 27	4 23	3 90
Spray materials	1.21	0 77	1.19	0.30
Veterinary	2.25	0 82	....	....
Plowing, fitting, and planting gardens	....	....	5 53	4.32
Hatching eggs	3.50	0 64	3 80	0 30
Use of buildings (interest, taxes, repairs, fire insurance)	21.80	9.91	48.00	0.75
Gardens purchased	....	....	5.00	0.08

On most farms there was not enough work to justify the expense of keeping a horse, and it was almost impossible to hire teams when they were needed.

The largest garden or livestock expenses for the town families, when all these families are considered, were for purchased feed for livestock, man and horse labor for plowing, fitting, and planting gardens, and garden seeds and plants, in the order named.

AVERAGE SIZE OF FARMS

The average size of the 11 farms included in the study was 15.1 acres (table 36), ranging from 2 acres to 48 acres. The purposes for which the land was used also are shown in the same table.

TABLE 36. AVERAGE SIZE OF FARMS, AND LAND UTILIZATION

Number of farms	Acres in					Total
	Crops	Woods not pastured	Woods pastured	Other permanent pasture	Farmstead, roads, and waste	
11	7.5	0.3	0.3	5.9	1.1	15.1

AVERAGE SIZE OF GARDENS

The average size of gardens cultivated by the 11 farm families and the 62 town families is shown in table 37. The farm gardens averaged nearly two-fifths of an acre in size. The largest farm garden covered one acre, and the smallest only 875 square feet. The town gardens averaged about one-half as large as those on the farms. One of the town families, however, had 1¼ acres in garden, which was the largest garden found either in town or on a farm. The smallest town garden covered only 400 square feet. The average size for the 73 gardens was approximately 9480 square feet, or between one-fourth and one-fifth of an acre.

TABLE 37. AVERAGE SIZE OF GARDENS ON FARMS AND IN TOWN

Home classification	Number in class	Average size (square feet)
Farm	11	16,101.4
Town	62	8,305.9
All homes	73	9,480.6

There were 34 kinds of vegetables, small fruits, and herbs grown in the 73 gardens surveyed (table 38). Tomatoes were grown in all but five of the 73 gardens, and sweet corn in all but seven. The other vegetables,

TABLE 38. KINDS OF VEGETABLES, SMALL FRUITS, AND HERBS GROWN BY 73 FAMILIES, GROTON, NEW YORK

Crop	Number of families raising
Tomatoes	68
Sweet corn	66
Beets	64
String beans	63
Cucumbers	62
Radishes	62
Lettuce	61
Green peas	50
Potatoes	48
Onions	42

TABLE 38 (*concluded*)

Crop	Number of families raising
Cabbage	32
Carrots	31
Squash	29
Rhubarb	24
Pumpkins	21
Dry beans	20
Turnips	19
Parsnips	18
Peppers	16
Cauliflower	13
Chard	9
Celery	8
Strawberries	8
Lima beans	6
Raspberries	6
Salsify	6
Asparagus	5
Spinach	5
Blackberries	2
Kohl-rabi	2
Pop corn	2
Dill	1
Parsley	1
Poppies	1

small fruits, and herbs are listed in the table in the order of the number of families growing them. Some crops, such as potatoes, were not found more frequently because of lack of space in small gardens. Crops which yield no returns during the year in which they are planted were found in a surprisingly small number of gardens. Only about one-third of the gardens contained rhubarb, eight gardens had strawberry beds, six had raspberries, five had asparagus, and two had blackberries. Only one of the families in rented homes was raising asparagus and rhubarb, while three others had strawberry beds in their gardens. Evidently the probability of moving is too great among the renters to start a crop from which they may not receive any returns. One family was raising dill to be used in pickling cucumbers, and poppies, the seeds of which were ground and used for seasoning bread.

PAY FOR FAMILY LABOR FROM FARMS, GARDENS, AND LIVESTOCK

The average pay for family labor from farms, and from gardens or livestock in town, is presented in table 39. The hours of labor necessary to obtain this income, and the net income per hour employed, also are given.

The average net income per family in payment for family labor on the 11 farms was $247.45. The corresponding figure for the gardeners and keepers of livestock in town was $45.73 per family. About 53 per cent of the farm work was performed by the husbands, 35 per cent by the sons, and the remaining 12 per cent by the wives. The average net income per hour employed on the farms was 24 cents. Three-fourths of the work

TABLE 39. AVERAGE PAY FOR FAMILY LABOR PER HOUR EMPLOYED ON FARMS, IN GARDENS, OR WITH LIVESTOCK

(75 families, Groton, New York)

Home classification	Farm	Garden or livestock	All families
Number in class	11	64	75
Total farm, garden, or livestock:			
Receipts per family	$718 27	$107.62	$197.19
Expenses per family	$470.82	$61.69	$121 87
Pay for family labor per family	$247.45	$45.73	$75.32
Hours employed on farms, in gardens, or with livestock:			
Husband	547.3	56.3	128.5
Wife	128.2	5.0	23.1
Sons	369.1	0.9	54.9
Daughters	....	0.5	0.4
Other members of family	....	12.8	10.9
Total hours employed	1,044.6	75.5	217.8
Net income per hour employed	$0.24	$0.60	$0.35

in gardens and with livestock in town was performed by the husbands, 7 per cent by the wives, less than 2 per cent by the sons and daughters, and the remainder by the fathers of either the husbands or the wives. The work performed in gardens and with livestock in town was much more efficient than that on the farms, the net income per hour employed being 60 cents. The average net income for all work done by members of the family on farms, in gardens, and with livestock, was 35 cents per hour.

There are many advantages of living on a farm that cannot be measured by statistics, such as the providing of safe and wholesome surroundings for the rearing of children, and the satisfaction of obtaining a large proportion of the food supply from its original source. On the other hand, farm life usually means more work for the housewife. Even if she performs the housework only, which is seldom the case, it is unusual for her to have the modern conveniences found in the majority of town homes. Running water, bathrooms, electric lights, and electrical appliances, cost much more in the farm homes and consequently are not often found there.

DETAILS OF ALL FOOD USED

Food is the most important single cost in the family budget. Up to this point, only summaries of these costs have been given. The details of quantities, cost or value, and percentage of cost or value, of the different kinds of food follow, a distinction being made between the amounts purchased and the amounts produced at home.

The five families that boarded for the entire year have been eliminated in this study. Also, the members of the ten families who boarded for varying periods have been eliminated for the period during which they boarded.

QUANTITIES OF FOOD

As far as it was practicable, the quantities of the different kinds of food used were obtained. These figures are reasonably complete for meat and meat products, poultry, eggs, and dairy products, and are given in table 40:

TABLE 40. QUANTITIES OF FOOD PURCHASED AND PRODUCED FOR HOME USE PER ANNUM

(87 households, Groton, New York)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	26	33	28	87
Average family income	$1,397.88	$1,911.12	$2,777.54	$2,036.59
Adult male equivalent	2 20	2 74	3 47	2.82
Meat and meat products:				
Beef (pounds):				
Purchased	135.3	209.1	214.2	188.7
Produced	....	....	....	....
Total:				
Per household	135.3	209.1	214.2	188.7
Per adult male equivalent	61.4	76.2	61.7	67.0
Veal (pounds):				
Purchased	12.4	23.7	48.5	28.3
Produced	....	....	8.9	2.9
Total:				
Per household	12.4	23.7	57.4	31.2
Per adult male equivalent	5.6	8.6	16.6	11.1
Pork (pounds):				
Purchased	86.8	110.3	148.2	115.5
Produced	27.1	25.6	25.2	25.9
Total:				
Per household	113.9	135.9	173.4	141.4
Per adult male equivalent	51.7	49.5	50.0	50.2
Mutton (pounds):				
Purchased	3.3	10.6	23.5	12.6
Produced	....	....	....	....
Total:				
Per household	3.3	10.6	23.5	12.6
Per adult male equivalent	1.5	3.9	6.8	4.5
Lard and lard substitutes (pounds):				
Purchased	49.2	53 5	89.1	63.7
Produced	....	....	....	....
Total:				
Per household	49.2	53.5	89.1	63.7
Per adult male equivalent	13.1	19.5	25.7	22.6
Fish (pounds):				
Purchased	13.1	25.5	45.1	28.1
Produced	....	....	....	....
Total:				
Per household	1 .1	25.5	45.1	28.1
Per adult male equivalent	6.0	9.3	13.0	10.0
Rabbits (pounds):				
Purchased	....	....	....	....
Produced	....	0.5	....	0.2
Total:				
Per household	....	0.5	....	0.2
Per adult male equivalent	....	0.2	....	0.1

TABLE 40 (*concluded*)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	26	33	28	87
Average family income	$1,397 88	$1,911 12	$2,777 54	$2,036 59
Adult male equivalent	2 20	2 74	3 47	2.82
Meat and meat products (*continued*):				
Total meat and meat products (pounds):				
Purchased	300.1	432.7	568.6	436.9
Produced	27.1	26.1	34.1	29.0
Total:				
Per household	327.2	458.8	602.7	465.9
Per adult male equivalent	139.3	167.2	173.8	165.5
Poultry (number):				
Purchased	2.6	5.3	6.3	4.8
Produced	4.1	2.6	8.6	5.0
Total:				
Per household	6.7	7.9	14.9	9.8
Per adult male equivalent	3.0	2.9	4.3	3.5
Eggs (dozen):				
Purchased	48.4	60.8	57.5	56.0
Produced	18.6	28 1	45.2	30.8
Total:				
Per household	67.0	88.9	102.7	86.8
Per adult male equivalent	30.4	32.4	29.6	30.8
Dairy products:				
Milk (quarts):				
Purchased	354.7	430.9	416.7	403.5
Produced	70.2	53.4	143.4	87.4
Total:				
Per household	424.9	484.3	560.1	490.9
Per adult male equivalent	192.9	176.5	161.4	174.3
Cream (quarts):				
Purchased	0.5	1.8	5.5	2.6
Produced	....	....	....	....
Total:				
Per household	0.5	1.8	5.5	2.6
Per adult male equivalent	0.2	0.7	1.6	0.9
Butter (pounds):				
Purchased	70.7	112.2	132.3	106.3
Produced	5.0	4.7	5.6	5.1
Total:				
Per household	75.7	116.9	137.9	111.4
Per adult male equivalent	34.4	42.6	39.7	39.5
Cheese (pounds):				
Purchased	23.7	29.5	40.0	31 2
Produced	....	....	....	....
Total:				
Per household	23.7	29.5	40.0	31.2
Per adult male equivalent	10.8	10.8	11.5	11.1
Cottage cheese (pounds):				
Purchased	10.5	4.7	1.1	5.3
Produced	....	....	....	....
Total:				
Per household	10.5	4.7	1.1	5.3
Per adult male equivalent	4.8	1.7	0.3	1.9

Meat and meat products

The only meats produced for home use were veal, pork, and a few rabbits. The total of the purchased and produced meat and meat products for all households averaged 67 pounds of beef, 50.2 pounds of pork, 11.1 pounds of veal, 10 pounds of fish, 4.5 pounds of mutton, and 22.6 pounds of lard and lard substitutes, per adult male equivalent. The total of all meat and meat products averaged 465.9 pounds per household for all households, or 165.5 pounds per adult male equivalent. The total quantity of meat and meat products per household increased fairly rapidly with the increase in family income, but the number of persons per household also increased in the same manner. The quantity of all meat and meat products per adult male equivalent increased from 139.3 pounds in the lowest income group to 173.8 pounds in the highest income group.

Poultry

Approximately one-half of the poultry used in these households was raised at home. The average number of poultry used in all households was 9.8, or 3.5 per adult male equivalent. There was very little variation in the number of poultry used per adult male equivalent as the family income increased.

Eggs

An average of 86.8 dozen eggs were used per household, or 30.8 dozen per adult male equivalent. In other words, the average was about one egg per day per adult male equivalent. There was no appreciable change in the number of eggs used per adult male equivalent as the family income increased.

Dairy products

Dairy products include milk, cream, butter, cheese, and cottage cheese. A considerable amount of milk was produced and some butter was made for home use. These households used an average of 174.3 quarts of milk (less than a pint a day), 39.5 pounds of butter, and 11.1 pounds of cheese, per adult male equivalent. The quantity of milk per adult male equivalent decreased with an increase in the family income, indicating that milk might have been used to a limited extent as a substitute for meat in the lower income groups.

COST OR VALUE OF FOOD

The cost of the different kinds and classes of food purchased, and the value of the kinds of food produced, are given in table 41. The percentages of the total cost or value of food represented by the different kinds and classes of food are shown in table 42.

Meat and meat products

The cost of meat and meat products constituted 21.8 per cent of the total food cost for all households (table 42). Beef was used to a greater extent than any other kind of meat. Pork was second choice. About 4 per cent of the meat consumed was produced at home. The average cost of meat and meat products for all households was $164.82, or $58.51 per adult male equivalent (table 41).

TABLE 41. AVERAGE ANNUAL COST OR VALUE OF ALL FOOD PURCHASED AND PRODUCED FOR HOME USE

(87 households, Groton, New York)

Family income group	$1600 or less	$1601 to $2000	Over $2000	Total
Number in group	26	33	28	87
Average family income	$1,397.88	$1,911.12	$2,777.54	$2,036.59
Adult male equivalent	2.20	2.74	3.47	2.82
Meat and meat products:				
Beef:				
Purchased	$48.92	$76.33	$78.32	$68.78
Produced	....	....	....	....
Total:				
Per household	48.92	76.33	78.32	68.78
Per adult male equivalent	22.21	27.82	22.56	24.42
Cost per pound	0.36	0.37	0.37	0.36
Veal:				
Purchased	4.42	8.58	18.14	10.41
Produced	....	....	1.61	0.52
Total:				
Per household	4.42	8.58	19.75	10.95
Per adult male equivalent	2.01	3.12	5.69	3.88
Cost or value per pound	0.36	0.36	0.34	0.35
Pork:				
Purchased	33.19	42.21	57.07	44.30
Produced	6.77	6.33	6.21	6.43
Total:				
Per household	39.96	48.54	63.28	50.73
Per adult male equivalent	18.14	17.69	18.23	18.01
Cost or value per pound	0.35	0.36	0.36	0.36
Mutton:				
Purchased	1.50	3.70	8.18	4.48
Produced	....	....	....	....
Total:				
Per household	1.50	3.70	8.18	4.48
Per adult male equivalent	0.68	1.35	2.36	1.59
Cost per pound	0.45	0.35	0.35	0.36
Lard and lard substitutes:				
Purchased	17.35	18.97	30.25	22.11
Produced	....	....	....	....
Total:				
Per household	17.35	18.97	30.25	22.11
Per adult male equivalent	7.87	6.91	8.71	7.85
Cost per pound	0.35	0.35	0.34	0.35
Fish:				
Purchased	3.54	7.27	12.25	7.76
Produced	....	....	....	....
Total:				
Per household	3.54	7.27	12.25	7.76
Per adult male equivalent	1.61	2.65	3.53	2.75
Cost per pound	0.27	0.29	0.27	0.28
Rabbits:				
Purchased	....	....	....	....
Produced	....	0.09	....	0.03
Total:				
Per household	....	0.09	....	0.03
Per adult male equivalent	....	0.03	....	0.01
Value per pound	....	0.17	....	0.17

TABLE 41 (*continued*)

Family income group	$1600 or less	$1601 to $2000	Over $2000	Total
Number in group	26	33	28	87
Average family income	$1,397 88	$1,911.12	$2,777.54	$2,036.59
Adult male equivalent	2.20	2.74	3 47	2.82
Total meat and meat products:				
Purchased	$108.92	$157.06	$204 21	$157.84
Produced	6.77	6 42	7.82	6.98
Total:				
Per household	115.69	163.48	212.03	164 82
Per adult male equivalent	52.52	59.57	61.08	58 51
Cost or value per pound	0 35	0.36	0.37	0.35
Poultry:				
Purchased	3.96	7.39	7 50	6.40
Produced	5.23	3 39	10.29	6.16
Total:				
Per household	9 19	10.78	17.79	12.56
Per adult male equivalent	4.17	3 93	5.12	4.46
Cost or value per fowl	1.37	1.36	1.19	1.28
Eggs:				
Purchased	26.23	33.55	30.68	30 44
Produced	9 27	14.97	22.82	15 79
Total:				
Per household	35.50	48.52	53.50	46.23
Per adult male equivalent	16 12	17 68	15.41	16.41
Cost or value per dozen	0.53	0 55	0.52	0 53
Dairy products:				
Milk:				
Purchased	37.85	49.79	50.68	46 51
Produced	7 15	5.33	15 93	9 29
Total:				
Per household	45.00	55 12	66.61	55.80
Per adult male equivalent	20.43	20 09	19 19	19.81
Cost or value per quart	0.11	0 11	0.12	0.11
Cream:				
Purchased	0.27	0 97	2 79	1.34
Produced	....	....	....	....
Total:				
Per household	0.27	0.97	2 79	1.34
Per adult male equivalent	0 12	0.35	0.80	0 48
Cost per quart	0 54	0 53	0.51	0.52
Butter:				
Purchased	41.12	65.97	75.89	61.74
Produced	2.77	2.70	2.82	2 76
Total:				
Per household	43.89	68 67	78.71	64 50
Per adult male equivalent	19.92	25 02	22.68	22.90
Cost or value per pound	0.58	0.59	0.57	0.58
Cheese:				
Purchased	8.58	10.64	14.36	11.22
Produced	....	....	....	....
Total:				
Per household	8.58	10.64	14.36	11.22
Per adult male equivalent	3.89	3.88	4.14	3.98
Cost per pound	0.36	0 36	0 36	0.36
Cottage cheese:				
Purchased	1.88	0.82	0.21	0.94
Produced	....	....	....	....

TABLE 41 (*concluded*)

Family income group	$1600 or less	$1601 to 2000	Over $2000	Total
Number in group	26	33	28	87
Average family income	$1,397.88	$1,911.12	$2,777.54	$2,036.59
Adult male equivalent	2.20	2 74	3.47	2.82
Dairy products (*continued*):				
Cottage cheese (*continued*):				
Total:				
Per household	$ 1 88	$ 0 82	$ 0.21	$ 0.94
Per adult male equivalent	0 86	0.30	0.06	0.33
Cost per pound	0.18	0 17	0.19	0.18
Total dairy products:				
Purchased	89.70	128 19	143.93	121.75
Produced	9 92	8 03	18.75	12.05
Total:				
Per household	99 62	136.22	162.68	133.80
Per adult male equivalent	45 22	49 64	46.87	47.50
Honey:				
Purchased	1 54	1 06	0.64	1.07
Produced	....	....	....	....
Total:				
Per household	1.54	1.06	0.64	1.07
Per adult male equivalent	0.70	0.39	0.19	0.38
Maple sirup and maple sugar:				
Purchased	2.12	1.24	1.75	1.67
Produced	....	0.18	0.21	0.14
Total:				
Per household	2.12	1.42	1.96	1.81
Per adult male equivalent	0 96	0 52	0.57	0.64
Fruit:				
Purchased	20 46	23 64	35.71	26.57
Produced	3.04	2.06	5 46	3.45
Total:				
Per household	23 50	25 70	41.17	30 02
Per adult male equivalent	10 67	9 36	11 86	10.66
Vegetables:				
Purchased	14.96	22.21	27.68	21.80
Produced	42.35	42.33	53.00	45.77
Total:				
Per household	57.31	64.54	80 68	67.57
Per adult male equivalent	26.02	23.52	23.24	23.99
Other groceries:				
Purchased	234 92	249 64	395.21	292.09
Produced	....	....	....	....
Total:				
Per household	234.92	249 64	395.21	292.09
Per adult male equivalent	106.65	90 97	113.86	103.71
Ice:				
Purchased	1.77	4.03	4.68	3.56
Produced	....	....	....	....
Total:				
Per household	1.77	4.03	4.68	3.56
Per adult male equivalent	0.80	1.47	1.35	1.27
Total food:				
Purchased	504.58	628.01	851.99	663.19
Produced	76.58	77.38	118.35	90.34
Total:				
Per household	581.16	705.39	970.34	753.53
Per adult male equivalent	263.83	257.05	279.55	267.53

TABLE 42. PERCENTAGE OF COST OR VALUE OF ALL FOOD REPRESENTED BY EACH KIND AND CLASS OF FOOD

(87 households, Groton, New York)

Family income group	$1600 or less	$1601 to $2000	Over $2000	All groups
Number in group	26	33	28	87
Average family income	$1,397.88	$1,911.12	$2,777.54	$2,036.59
Adult male equivalent	2.20	2.74	3.47	2.82
Meat and meat products:				
Beef	8.4	10.8	8.1	9.1
Veal	0.8	1.2	2.0	1.5
Pork	6.9	6.9	6.5	6.7
Mutton	0.3	0.5	0.8	0.6
Lard and lard substitutes	3.0	2.7	3.1	2.9
Fish	0.6	1.0	1.3	1.0
Rabbits	0.0	......*	0.0	......*
Total meat and meat products	20.0	23.1	21.8	21.8
Poultry	1.6	1.5	1.8	1.7
Eggs	6.1	6.9	5.5	6.1
Dairy products:				
Milk	7.7	7.8	6.9	7.4
Cream	......*	0.1	0.3	0.2
Butter	7.6	9.7	8.1	8.6
Cheese	1.5	1.5	1.5	1.5
Cottage cheese	0.3	0.1	......*	0.1
Total dairy products	17.1	19.2	16.8	17.8
Honey	0.3	0.2	0.1	0.1
Maple sirup and maple sugar	0.4	0.2	0.2	0.2
Fruit	4.0	3.6	4.2	4.0
Vegetables	9.9	9.2	8.3	9.0
Other groceries	40.3	35.5	40.8	38.8
Ice	0.3	0.6	0.5	0.5
Total	100.0	100.0	100.0	100.0
Food derived from:				
Animal products	45.1	50.9	46.0	47.5
All other sources	54.9	49.1	54.0	52.5

* Less than 0.1 per cent.

Poultry

The cost of poultry represented 1.7 per cent of the total food cost (table 42). Approximately one-half of the poultry used was produced at home. The average cost or value of all poultry used was $1.28 per fowl (table 41).

Eggs

The cost of eggs made up 6.1 per cent of the total food cost in the 87 households (table 42). Slightly more than one-third of the eggs used were produced at home. The average cost or value of eggs for all households was $46.23, or $16.41 per adult male equivalent (table 41); the average cost per dozen was 53 cents.

Dairy products

The total value of all dairy products, consisting of milk, cream, butter, cheese, and cottage cheese, averaged $133.80 per household, or $47.50

per adult male equivalent (table 41). The cost of dairy products constituted 17.8 per cent of the total food cost (table 42), with butter making up about one-half of the cost of these products. About one-sixth of the milk used was produced at home.

Fruit

An average of 4 per cent of the food expenditures in the 87 households was for fruit (table 42). The average cost per household for fruit was $30.02 (table 41). Approximately 11 per cent of the fruit used was raised at home.

Vegetables

Vegetables formed the principal class of home-produced food. Approximately two-thirds of the vegetables used came from the home gardens. Their cost constituted 9 per cent of the total food cost of all families (table 42). There was a slight decrease in the percentages of the total food cost represented by vegetables as the family income increased.

Other groceries

The average cost of all other groceries was $292.09 per household, or $103.71 per adult male equivalent (table 41).

Ice

Ice was included in the budget as a food cost. It was used in only 28 of the 87 homes An average of 18.9 hundredweight of ice was used in the 28 homes, or 7.6 hundredweight per adult male equivalent. This ice cost $11.07 per household using ice, or $4.46 per adult male equivalent.

All foods

The average cost or value of all food was $753.53 per household, or $267.53 per adult male equivalent (table 41). There was no appreciable change in the cost per adult male equivalent as the family income increased. About 12 per cent of the total value of food used in these households was produced at home.

The proportion of all food derived from animal products was 47.5 per cent for all households (table 42). There is no appreciable change in the percentage of the total food cost represented by animal products when the data are studied by income groups. In Engel's (1895: 38–42) work with the Belgian budgets, the proportion of all food derived from animal products for all families was about 23 per cent, and the range was from approximately 16 per cent for the families in the lowest income group to about 27 per cent for those in the highest income group. These percentages merely indicate that animal food was a luxury in Belgium even at that time (1853). Undoubtedly, if data were available for the food budgets of workingmen in that country at the present time, the percentage spent for animal food would be still smaller.

COMPARISON OF ALL FOOD BY HOME CLASSIFICATIONS

The average cost or value of all food used in the households is compared according to the different home classifications in table 43. About 27 per cent of the food used in the farm homes, and about 10 per cent of the food used in the town homes having gardens or livestock, was produced

TABLE 43. COMPARISON OF THE AVERAGE ANNUAL COST OR VALUE OF ALL FOOD USED, BY HOME CLASSIFICATIONS
(87 families, Groton, New York)

Home classification	Farm	Garden or livestock	No garden nor livestock
Number in class	11	64	12
Adult male equivalent	4.35	2.67	1.89
Average family income	$2,666.81	$1,937.93	$1,985.00
Cost of purchased food per household	$ 818.18	$652.27	$579.50
Value of home-produced food per household	297.00	71.75	....
Total value of food used:			
Per household	1,115.18	724.02	579.50
Per adult male equivalent	256.36	271.06	306.34

at home. The average cost of all food per household was highest for the farm homes and lowest for the town homes with no gardens nor livestock, but the farm families were considerably larger. The average cost per adult male equivalent exactly reverses this order.

RELATION OF THE NUMBER OF ADULT MALE EQUIVALENTS IN A HOUSEHOLD TO THE TOTAL FOOD COST

A study was made of the relation of the number of adult male equivalents in a household to the total cost of food, the data being arranged in the order of the number of adult male equivalents per household beginning with the lowest. The results of this study are given in table 44:

TABLE 44. RELATION OF THE NUMBER OF ADULT MALE EQUIVALENTS IN A HOUSEHOLD TO THE TOTAL FOOD COST
(84 households, Groton, New York)

Adult-male-equivalent group	Number in group	Average adult male equivalent	Average family income	Cost of purchased food per household	Value of home-produced food per household	Total value of food used	
						Per household	Per adult male equivalent
1–1.99	19	1.50	$1,899.05	$ 404.11	$ 39.32	$ 443.43	$294.79
2–2.99	37	2.41	1,806.97	608.00	62.41	670.41	278.27
3–3.99	19	3.25	2,261.32	688.05	156.53	844.58	259.95
4–4.99	5	4.43	2,253.20	933.00	112.00	1,045.00	236.00
5–5.99	4	5.28	2,225.50	1,032.25	128.75	1,161.00	219.78
All groups	84	2.65	1,977.06	619.54	84.58	704.12	265.56

Although the total food cost per household increased about 162 per cent from households with the smallest number of adult male equivalents to those with the largest number, the cost per adult male equivalent decreased approximately 25 per cent.

The decreasing cost of food per capita in larger families in a number of States and in other countries has been reported by the United States Labor Commissioner (1891: 664).

THE SMALL TOWN AS A FACTORY SITE

Some of the advantages and disadvantages of the small town as a factory site have already been brought out by the statistics in the preceding pages. Others, which cannot be measured in figures, have been formulated from the opinions of several factory employers and employees. A few of these advantages follow.

The opportunities for the employees to own their homes are good (page 15). In fact, it has become almost imperative that the employees in the Groton factories should own their homes, since houses for rent are very scarce.

Living expenses are lower in the small town, which provides a better opportunity to save money (page 32).

The small town furnishes ample opportunity for cultivating garden plots. In case some of the employees are interested in something more than garden plots in town, there are usually opportunities to obtain small farms near at hand at reasonable prices. The work performed in gardens or on small farms is usually well compensated for by the products received (page 47).

Most of the employees of a factory in a small town are likely to be natives of the town or of the surrounding community (page 6). The factory should be benefited by this more permanent and uniform labor force.

Social and recreational work can be better organized and much more effectively conducted in the small-town factory than in the city factory, since there is very little competition from other sources in the small town. If there is good team work among the employees during their leisure hours, the same spirit usually prevails during the working hours.

The principal disadvantages which this study has brought out are as follows:

With a rapidly expanding business, it is sometimes difficult to get sufficient labor. This was evidenced in Groton by the fact that the Corona Typewriter Company maintained four motor busses to transport employees from distant points (page 6). Even if the cost of operation of these busses was covered by the fares charged the employees, the responsibility of watching this additional detail rested with the factory management.

A number of the employees mentioned as a decided disadvantage the possibility of the factory's shutting down, with no other work available in the town. This would mean a particular hardship to the employees who owned their homes. Not only would the value of the homes greatly depreciate in a town with no work available, but there would be difficulty in disposing of the property at any figure.

There seemed to be an opinion that the transportation problem is more serious in the small town than in the city. Shipments of raw materials to the factory are slower, and the difficulties in getting cars for shipping the finished product are greater, in the small town. It was also thought that freight rates are more advantageous to the city factory than to the small-town factory.

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Home and Business Record of a Family

No.........

Prepared by Department of Farm Management, New York State College of Agriculture at Cornell University, Ithaca, N. Y.

1.—County........................State..........................Record for year ending......... ....19....

Name...Street..............................No.............P. O.......................................

2. Members of Household

Member	Months at home during year	Nationality	Sex	Age	Years lived on farms	SCHOOLS				
						Highest attended	Years	Grade if in school	Distance	Conveyance
Husband			X					X	X	X
Wife			X					X	X	X
Children		X								
		X								
		X								
		X								
		X								
		X								
Hired help		X			X	X	X	X	X	X
		X			X	X	X	X	X	X
		X			X	X	X	X	X	X
Other					X	X	X	X	X	X
					X	X	X	X	X	X
					X	X	X	X	X	X
Self-supporting										

Number of sons not at home during the year........................

Number of daughters not at home during the year........................

3. Occupation of Head of Household

When time is entered for work done on own farm or in own garden, write "farm" or "garden" in occupation column

Firm	Occupation	Days employed	Cash wages	Bonuses or overtime	WAGES NOT CASH		Total
					Item	Dollars	
			$	$		$	$
Other earnings							
Total	X		$	$	X	$	$

Miles to work, state road................dirt road...............Total....................Conveyance....................

4. Occupation of Other Members of Household

Do not enter here the self-supporting members of household. When time is entered for work on own farm or in own garden, write "farm" or "garden" in occupation column

Member	Occupation	Conveyance	Days employed	Rate of pay	TOTAL Cash	TOTAL Other	Board farm help
				$	$		X
							X
							X
							X
							X
							X
Received from roomers and boarders, members of family							
Not members of family							
				Total	$		

5. The Home

Value of buildings	At beginning of year	At end of year	Item	House	Other buildings	TOTAL Cash	TOTAL Other
House	$	$	Taxes, all kinds	$	$	$	X
Other (list kind)			Fire insurance				X
			Repairs, cash				X
			Interest on mortgage				X
			Interest on average value, less mortgage, @—%			X	
Average value of house $			Depreciation			X	
Average value of other buildings $			Rent paid				X
Amount of mortgage $ @ %			Total				
What would house rent for per year, if owned by occupant $			Deduct appreciation, if any			X	
			Cost of upkeep or rent				
Number of rooms			Per cent farm use	%	%	%	%
Bathroom and toilet			Dollars farm use				
Year last painted			Dollars other use				

General appearance; good, medium, poor

6. Home Conveniences

Item	Kind	Amount	Price	Yearly cost or value	FARM USE		TOTAL LESS FARM USE	
					Per cent	Value	Cash	Other
Light	Electric	X	$	$		$	$	$ X
	Gas	X						X
	Kerosene	gal.						X
Heat	Coal	tons						X
furnace	Wood	cds.						X
stove	Kerosene	gal.						X
	Gas	X	X					X
Water	City	X	X					
	Pump inside	X	X					
	Pump outside	X	X					
	Cistern	X	X					
	Spring	X	X					
	Open well	X	X					
Telephone	X	X	X					X
Auto								
gasoline	X	gal.				Going to work	X	X
repairs	X	X	X			Other business	X	X
insurance	X	X	X			Pleasure	X	X
license	X	X	X		X	X	X	X
depreciation	X	X	X		X	X	X	X
other	X	X	X		X	X	X	X
Other conveniences								
(list kind)								

Total yearly cost of conveniences $ $

7. Purchased Food

Kind	Amount	Price	Value
Meat products	X	X	X
beef	lbs.	$	$
veal	lbs.		
pork	lbs		
mutton	lbs.		
lard	lbs.		
fish	lbs		
Dairy products	X	X	X
milk	qts.		
cream	qts.		
butter	lbs.		
cheese	lbs.		
cottage cheese	lbs.		
Poultry and eggs	X	X	X
poultry	no.		
eggs	doz		
Fruit	X		
Vegetables	X		
Honey	lbs.		
Maple syrup	gal		
Other groceries	X		
Ice	cwt.		
Total	X	X	$

Have you decreased the amount of meat used because of high cost

........%; milk........%; eggs........%

8. Miscellaneous Expenses

KIND	FARM USE %	FARM USE Value	TOTAL Less farm use
Books, papers, and magazines		$	$
Car fare			
Charity			
Church			
Clothing			
Doctors, dentists, and medicine			
Educational			
Entertainment			
Furniture			
House supplies			
Insurance, furniture			
life			
Laundry			
Organization dues			
Hired help (domestic) days			
Stamps and stationery			
Traveling			
War relief			
Washing, cleaning, etc., days			
Other expenses (list kind)			
Total	X	X	$

9. Livestock Products

Product	FOR HOME USE				SOLD OR TO BE SOLD	
	Human food		Animal food			
	Amount	Value	Amount	Value	Amount	Value
Whole milk	qts.	$	qts.	$	qts.	$
Cream	qts		X	X	qts.	
Skimmilk	qts.		qts.		qts.	
Buttermilk	qts.		qts.		qts.	
Cheese	lbs.		X	X	lbs.	
Wool	X	X	X	X	lbs.	
Eggs	doz.		X	X	doz.	
Hatching eggs	X	X	X	X		
Day-old chicks	X	X	X	X		
Breeding fees, kind	X	X	X	X		
Hides, kind	X	X	X	X		
Honey	lbs.		X	X	lbs.	
Total	X	$	X	$	X	$

10. Miscellaneous Receipts

Enter any money received for time or labor of hired help off the farm and for other things noted below

RECEIVED FOR	CASH		HOME USE	
	Amount	Value	Amount	Value
Man labor off farm	days	$	X	$ X
Team work off farm	days		X	X
Machine work or use of machinery	days		X	X
Jury, assessor, etc.	days		X	X
Cash rent for land	acres		X	X
Stock pastured, kind			X	X
Boarding stock, kind			X	X
Rent of buildings, kind			X	X
Maple syrup, sugar	gal. lbs.		gal. lbs.	
Lumber, posts, wood, etc.				
Insurance, kind			X	X
Any other receipt				
Total miscellaneous receipts	X	$	X	$

II. Crops

CROP	CROPS GROWN			DISPOSAL OF CROP					
				For home use				Sold or to be sold	
				Human food		Animal food			
	Acres	Yield per acre	Total crop	Amount	Value	Amount	Value	Amount	Value
Corn for grain (shelled)		bu.			$		$		$
Corn for silage		tons		X	X				
Fodder corn (green weight)		tons		X	X				
Sweet corn		tons							
Potatoes		bu.							
Field beans		bu.							
Cabbage		tons							
Tobacco		lbs.				X	X		
Root crops, kind		bu.							
Buckwheat		bu.							
Oats and barley		bu.		X	X				
Oats and peas		bu.		X	X				
Oats		bu.							
Barley		bu.							
Winter wheat		bu.							
Rye		bu.							
Straw	X	X	X	X	X				
Alfalfa (No. cuttings........)		tons		X	X				
Hay, clover, timothy (No. cut.........)		tons		X	X				
Oat hay		tons		X	X				
Apples bearing		bbls.							
Cider apples, driers, and other seconds	X	cwt.							
Peaches bearing		bu.							
Cherries bearing		lbs.				X	X		
Pears bearing		bu.							
Fruit not of bearing age		X	X	X	X	X	X	X	X
Berries		qts.				X	X		
Tomatoes		tons							
String beans		cwt.				X	X		
Green peas		cwt.				X	X		
Any other crops									

11. Crops (*concluded*)

CROP	CROPS GROWN			DISPOSAL OF CROP					
				For home use				Sold or to be sold	
				Human food		Animal food			
	Acres	Yield per acre	Total crop	Amount	Value	Amount	Value	Amount	Value
Other garden	X	X	X	X	$	X	$	X	$
Total acreage of crops		Total Values			$	X	$	X	$
Acres double-cropped									
Difference = acres used for crops									
Woods not pastured									
Woods pastured									
Other permanent pasture									
Other land pastured thruout season									
Farmstead, roads, fence rows									
Other land									
Total acres [1]									

12. Land Area

ITEM	ACRES	SQUARE FEET
Owned		
Cash-rented		
Share-rented		
Total area		
Garden		

NOTE: 1.–Should equal total acres as given in part 12.

13. Livestock

KIND		BREED	BEGINNING OF YEAR			END OF YEAR			SALES			PURCHASES			NO. died during year	HOME USE	
			No.	Value per head	Total value	No.	Value per head	Total value	No.	Price per head	Total received	No.	Price per head	Total paid		No.	Value
Dairy cows	grade			$	$		$	$		$	$		$	$			$
	purebred																
Dairy heifers	grade																
	purebred																
Veal calves																	
Bulls	grade																
	purebred																
Beef cattle																	
Horses (No. mares ----)																X	X
Mules																X	X
Stallions																X	X
Colts																X	X
Ewes	breeding																
	yearling																
Bucks																	
Lambs, weaned																	
Fattening sheep																	
Brood sows																	
Boars																	
Other hogs																	
Pigs, weaned																	
Chickens																	
Ducks																	
Geese																	
Turkeys																	
Bees																X	X
Totals		X	X	X	$	X	X	$	X	X	$	X	X	$	X	X	$

14. Farm Expenses[2]

	CASH	OTHER
Year help (months........)	$	$
Value of board furnished year help (months .. ....)		
Month help (months.......)		
Value of board furnished month help (months........)		
Day help (days........)		
Value of board furnished day help (days ....)		
Advertising		
Baling		
Barrels, baskets, bags, egg cases		
Breeding fees		
Buildings, new		
Building repairs, roofing, paint, etc.		
Cash rent for........acres		
Cash rent for pasturage		
Commissions, storage		
Freight, express, etc.		
Drains		
Hay, silage, stalks, straw		
Feeds, grain bought for horses, cows, poultry, hogs, and sheep, including salt, beef-scrap, grit, etc.		
Feed grinding		
Fence, wire, posts, staples, etc.		
Fertilizer		
Lime		
Manure		
Horseshoeing		
Insurance		
Lumber sawing		
Machinery, wagons, harness, etc.		
Machinery repairs, tires, plow points, sections, etc.		
Machines hired, as drill, harvester, etc.		
Silo filling, corn shredding or husking		
Threshing		
Coal, oil, gasoline, etc., for farm use		
Twine		

NOTE: 2.—All farm expenses listed elsewhere in this blank should be brought under this heading.

15. Capital

ITEM	Value at beginning of year	Value at end of year
Land (without buildings)		
Machinery, wagons, harness, etc.		
Feed, seed, and supplies		
Livestock (part 13)		
Totals		

Average capital $........................

16. Summary

	PART	CASH	OTHER	TOTAL
THE FARM		$	$	$
RECEIPTS				
Increase in capital	15	X		
Crops for human food	11	X		
Crops sold	11		X	
Livestock for human food	13	X		
Livestock sold	13		X	
Livestock products for human food	9	X		
Livestock products sold	9		X	
Miscellaneous, home use	10	X		
Miscellaneous, cash	10		X	
Total farm receipts				
EXPENSES				
Decrease in capital	15	X		
Livestock purchased	13		X	
Farm expenses	14			
Total farm expenses				
Income from capital and family labor				
Interest on average capital @............%		X		
Family farm income				
Total earnings of head of household off the farm	3			
Total earnings of other members of household off the farm	4			
Total family income				
Rent or upkeep	5			
Home conveniences	6			
Purchased food	7		X	
Miscellaneous expenses	8		X	
Total family expenses				
Available for savings		$	X	X

14. **Farm Expenses** (*concluded*)

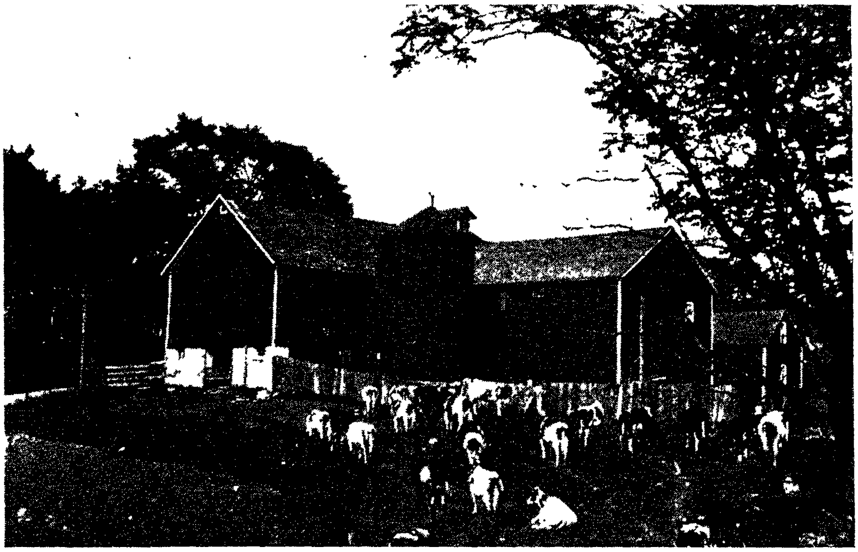
	CASH	OTHER
Farm share of upkeep and operation of auto	$	$
Ice		
Milk hauling		
Milk bottles, cans, strainers, etc.		
Cow tester, acid, fees, etc.		
Registration fees		
Seed, grass		
Other seeds, plants, trees		
Spray materials		
Stamps and stationery for farm use		
Telephone and toll for farm use		
Taxes including school tax, farm share		
Veterinary, medicines, disinfectant		
Any other farm expenses		
Total	$	$

17. **How much was saved during the year $........**

September, 1924 Bulletin 432

An Economic Study of Dairying on 163 Farms in Herkimer County, New York

E. G. Misner



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CONTENTS

AN ECONOMIC STUDY OF DAIRYING ON 163 FARMS IN HERKIMER COUNTY, NEW YORK

E. G. MISNER[1]

The results of a cost study concerning production problems on certain New York dairy farms, reported in this publication, were obtained in the summer of 1919 and apply to the year ending April 30, 1919.

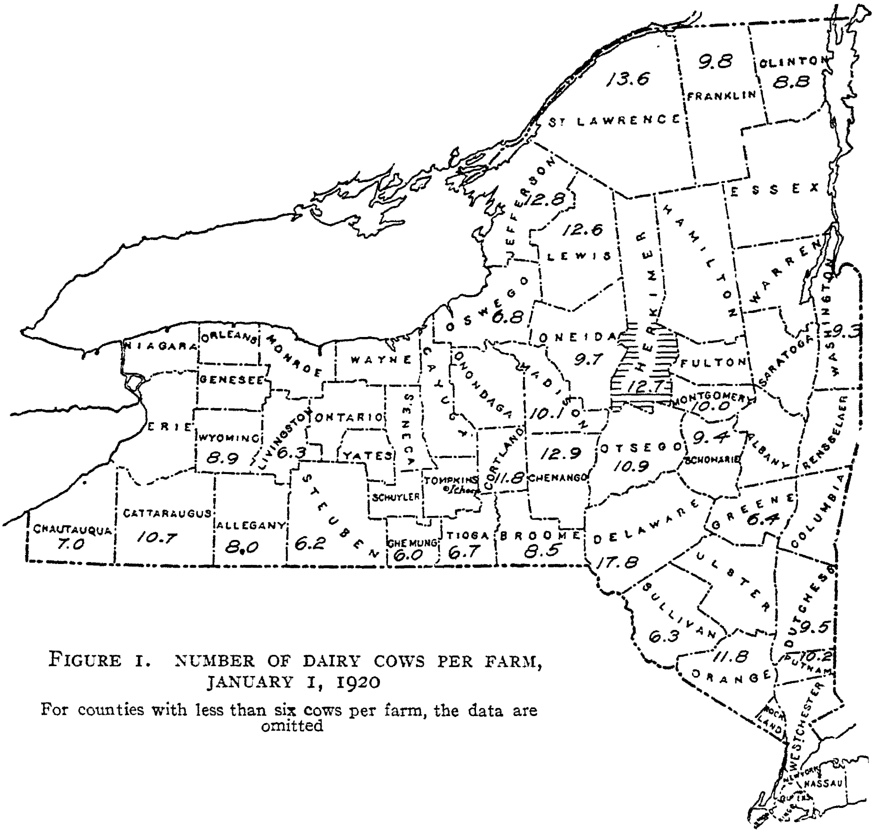

FIGURE 1. NUMBER OF DAIRY COWS PER FARM, JANUARY 1, 1920

For counties with less than six cows per farm, the data are omitted

For the United States, the price level of "all commodities" for the twelve months for which the results apply was 201 as compared with that for 1913 as 100. Thus the financial situation prevailing for the year when the results apply was a general price level of more than twice the average for 1913, just preceding the World War. Whenever conclusions are drawn from this report, therefore, they should always be with acknowledgment of contemporary currency values.

[1] D. G. Card, L. D. Somers, and E. B. TerBush, jr., assisted the writer in the field work.

REGIONAL CONDITIONS

Herkimer County is a long, narrow county at the foot of the Adirondacks. The northern half is of little agricultural value because of its mountainous character. The southern half varies widely in topography and soils, but is generally more adapted to successful farming than is the northern half. The Mohawk River, flowing east, about equally divides the southern half of the county. The West Canada Creek, coming from the north, joins the Mohawk at Herkimer. The farms included in this study are north of the Mohawk, and in the West Canada Creek valley or on the uplands adjacent, in the towns of Herkimer, Fairfield, Newport, and Norway. Of the total number, 54, or 33 per cent, are classed as valley farms. Many of the farms are situated at an elevation of from 1200 to 1600 feet above sea level. The average elevation is 941 feet.

No soil survey has been published for Herkimer County. The soils of the West Canada Creek valley range from gravelly sandy to clay loams. This is a new valley. Its territory was once an old lake bed. Trenton limestone outcrops in some places, and the soils of some farms, occasionally the pastures as well as the crop areas, are influenced by it.

In the town of Fairfield there are many strong dark glacial soils, often in need of drainage and some lime but otherwise rich soils. These have resulted from weathering of calcareous shale rocks. Whenever pastures are found on such soil they are very abundant. The many rich pastures of the Canada Creek and Fairfield regions, together with an abundant summer rainfall, provide natural advantages for the production of summer milk, and for many years Herkimer County cheese in the larger markets was a brand of quality.

In another class are those non-calcareous, glacial till soils derived from dark gray shales and sandstones, probably of the Volusia, Lordstown, or Wooster series. The Volusia occupies level to rolling hilltops and is underlain with a heavy brown subsoil. The Lordstown comprises the steeper phases. In the valleys and along the hills are the deeper and better soils of the Wooster series. Most of these soils need lime and are much less productive potentially than those of the two preceding classes.

Herkimer County is primarily a dairy county. There are four large condenseries, at Newport, Middleville, Frankfort, and Little Falls, and in 1918 there were 22 milk stations and 22 cheese factories in the county. The cheese factories are rapidly being closed and the milk is going to the condenseries, a change which the war stimulated in many New York regions.

TENURE AND AGE OF FARMERS

No selection of farms was made other than to include largely dairymen delivering milk at Herkimer, Kast Bridge, Middleville, Newport, and Poland. Of the 163 farmers, 107 owned all of the land they farmed, 2 owned part and share-rented additional land, and 6 owned part and cash-rented additional land. There were 37 who share-rented and 11 who cash-rented all of the land they operated. The average acres per farm were 153 acres for owned farms, 179 acres for share-rented farms, 217 acres for cash-rented farms, 188 acres for farms part owned and part share-rented, and 273 acres for farms part owned and part cash-rented. The average acres rented for farms part owned and part share-rented

were 130, and for farms part owned and part cash-rented 45. The average for all farms was 168 total acres, of which 68 acres, or 40.5 per cent, were in crops, and 91 acres, or 54.2 per cent, were in pasture. The balance, 5.3 per cent, was farmstead, roads, woods, fence land, and waste. The average distance to milk stations was 2.8 miles. The average age of the farmers was 47 years. (Table 1.)

TABLE 1. Tenure, Location, Size, Distance to Station, and Elevation, of Farms, and Age of Farmers

	Farms owned	Farms share-rented	Farms cash-rented	Farms part owned and part share-rented	Farms part owned and part cash-rented	All farms
Total number of farms	107	37	11	2	6	163
Number of valley farms	32	15	3	2	2	54
Number of upland farms	75	22	8	......	4	109
Per cent of upland farms	70	59	73	......	67	67
Acres farmed per farm	153	179	217	188	273	168
Acres owned	153	......	......	58	228	110
Acres share-rented	......	179	......	130	......	42
Acres cash-rented	......	......	217	......	45	16
Acres of crops	61	74	91	80	98	68
Acres of pasture	84	94	120	100	131	91
Miles to milk station	2.8	2.5	2.8	0.1	3.9	2.8
Elevation of farms (feet)	942	925	1,004	550	1,036	941
Age of farmers (years)	49	41	44	36	50	47

The distribution of ages of operators is shown in table 2:

TABLE 2. Age of Operators

Age (years)	Number of farmers of each age					All farms
	Owner	Share-renter	Cash-renter	Owner, share-renting additional land	Owner, cash-renting additional land	
21	....	1	....	....	....	1
22	....	1	....	....	....	1
25	2	1	....	....	....	3
28	1	4	....	....	....	5
29	2	....	....	....	1	3
30	1	1	....	....	....	2
31	....	2	....	....	....	2
32	....	1	....	....	....	1
33	4	....	....	....	....	4
34	2	2	....	1	....	5
35	4	2	....	....	....	6
36	1	1	2	....	....	4
37	1	....	2	....	....	3
38	5	1	1	1	....	8
39	2	1	....	....	....	3

TABLE 2 (*concluded*)

Age (years)	Number of farmers of each age: Owner	Share-renter	Cash-renter	Owner, share-renting additional land	Owner, cash-renting additional land	All farms
40	3	1	....	....	....	4
41	4	2	....	....	....	6
42	4	1	....	....	....	5
43	1	....	....	....	....	1
44	4	1	....	....	1	6
45	2	2	....	....	....	4
46	2	....	2	....	....	4
47	5	....	....	....	....	5
48	1	2	1	....	1	5
49	2	1	....	....	....	3
50	3	....	1	....	....	4
51	1	....	....	....	....	1
52	5	....	1	....	....	6
53	6	1	....	....	....	7
54	2	1	....	....	1	4
55	3	....	1	....	....	4
56	2	1	....	....	....	3
57	3	....	....	....	....	3
58	3	1	....	....	....	4
59	3	....	....	....	....	3
60	4	1	....	....	....	5
61	3	2	....	....	1	6
62	2	2	....	....	....	4
63	4	....	....	....	1	5
64	1	....	....	....	....	1
65	3	....	....	....	....	3
67	3	....	....	....	....	3
68	1	....	....	....	....	1
71	1	....	....	....	....	1
75	1	....	....	....	....	1
Total	107	37	11	2	6	163

COSTS FOR ALL CATTLE

The costs are for feed, bedding, labor, hauling milk, use of buildings, use of equipment, interest, and miscellaneous charges.

Feed

Home-grown feed for cows was charged at its farm value, that is, the market value less the cost of marketing. Purchased feed was charged at cost.

Grain and other concentrates

On the farms studied, 95 per cent of the concentrates were purchased and 89 per cent were by-products. About two-thirds of the home-grown grain was oats. The average price of grains purchased was $62.20 per ton (table 3). In Herkimer County in 1919, 26 per cent of the feeds used by cattle were unmixed and 74 per cent were compounded. In

TABLE 3. Concentrates Used by 4136 Cows, 1410 Heifers, and 230 Herd Bulls

Kind of feed	Total herds				Cows			Heifers			Herd bulls		
	Number of herds using	Number of pounds used	Average price per ton	Value	Number of pounds used	Average price per ton	Value	Number of herds using	Number of pounds used	Value	Number of herds using	Number of pounds used	Value
Home-grown:													
Oats	60	188,300	$55.58	$5,233	139,960	$56.13	$3,928	28	43,500	$1,169	15	4,840	$136
Corn	21	36,600	66.01	1,208	34,050	65.79	1,120	5	1,800	64	4	750	24
Barley	8	31,500	40.06	631	26,200	40.69	533	3	4,900	91	1	400	7
Oats and barley	2	25,700	51.52	662	19,800	51.82	513	2	4,400	111	2	1,500	38
Wheat bran	4	3,500	58.86	103	3,500	58.86	103	...	...	...	...	...	...
Oats and peas	1	1,000	50.00	25	1,000	50.00	25	...	...	...	...	...	...
Buckwheat	1	100	20.00	1	100	20.00	1	...	...	...	...	...	...
Total home-grown	...	286,700	$54.85	$7,863	224,610	$55.41	$6,223	...	54,600	$1,435	...	7,490	$205
Purchased:													
Ground oats	47	220,300	$ 53.48	$ 5,891	182,800	$53.38	$ 4,879	28	31,100	$ 835	18	6,400	$177
Cornmeal	51	100,600	66.52	3,346	87,800	66.20	2,906	21	10,500	359	10	2,300	81
Corn and oats	5	64,000	61.22	1,959	51,500	60.58	1,560	3	10,900	348	3	1,600	51
Barley feed	17	37,900	53.93	1,022	34,200	53.98	923	7	3,000	80	4	700	19
Hominy	10	24,100	64.81	781	21,800	64.59	704	3	1,200	42	2	1,100	35
Oats and barley	3	16,200	51.23	415	14,800	51.35	380	1	1,200	30	1	200	5
Oatmeal	2	300	133.33	20	...	...	...	2	300	20	...	...	...
Wheat bran	66	190,200	50.06	4,761	154,000	50.25	3,869	35	31,500	772	10	4,700	120
Wheat feed	26	96,600	52.57	2,539	85,700	52.18	2,236	7	8,900	249	5	2,000	54
Wheat middlings	25	41,600	54.18	1,127	36,500	54.36	992	10	4,300	113	4	800	22
Cottonseed feed	1	3,000	50.00	75	3,000	50.00	75	...	...	...	...	...	...
Molasses and molasses feeds:													
H. O. molasses feed	10	55,600	57.48	1,598	53,700	57.50	1,544	3	1,100	31	3	800	23
Molasses	7	30,000	56.73	851	29,500	56.68	836	2	400	12	1	100	3
H. O. milk feed	4	23,000	54.43	626	20,000	54.40	544	3	2,300	63	3	700	19
H. O. stock feed	1	2,800	55.71	78	2,800	55.71	78	...	...	...	...	...	...
Purina Cow Chow	12	107,000	62.37	3,337	104,040	62.42	3,247	3	2,600	79	2	360	11
Mormilk	8	92,100	63.67	2,932	89,400	63.65	2,845	1	2,300	74	1	400	13
International Ready Ration	1	72,000	54.50	1,962	65,300	54.49	1,779	1	6,000	164	1	700	19
International Climax Feed	4	47,200	50.55	1,193	44,900	50.56	1,135	2	2,100	53	2	200	5
Faramel	2	10,000	66.00	330	3,800	65.79	125	2	6,200	205	...	...	...
International Stock Feed	3	8,200	62.20	255	8,200	62.20	255	...	...	...	...	...	...
Mixed feeds:													
Schumacher	29	181,000	57.60	5,213	143,600	57.58	4,134	13	32,800	947	9	4,600	132
Portage Stock	1	10,000	55.00	275	5,200	55.00	143	1	4,000	110	1	800	22
Arcady Stock	2	7,700	50.39	194	7,700	50.39	194	...	...	...	...	...	...
Grandin's Mixed Feed	1	6,000	51.00	153	3,300	50.91	84	1	2,500	64	1	200	5
Badger's	2	3,500	59.43	104	3,500	59.43	104	...	...	...	...	...	...
Buffalo Mixed	1	2,000	55.00	55	2,000	55.00	55	...	...	...	...	...	...
Lucky Strike	1	1,200	58.33	35	1,200	58.33	35	...	...	...	...	...	...

TABLE 3 (*concluded*)

Kind of feed	Total herds				Cows			Heifers			Herd bulls		
	Number of herds using	Number of pounds used	Average price per ton	Value	Number of pounds used	Average price per ton	Value	Number of herds using	Number of pounds used	Value	Number of herds using	Number of pounds used	Value
Purchased (*continued*):													
Dairy Feed	1	500	64.00	16	500	64.00	16	....	......	......	....	......	......
Kinds not found (low protein)	2	8,200	48.29	198	7,900	48.35	191	1	300	7	....	......	......
Larro Feed	56	1,204,800	63.24	40,939	1,219,800	63.10	38,523	28	62,500	2,012	20	12,500	401
Union Grains	66	882,600	67.88	29,956	847,000	67.91	28,761	19	26,800	807	10	8,800	298
Unicorn	16	78,800	65.94	2,598	77,100	65.91	2,541	7	1,100	37	2	600	20
Big Q	27	231,500	63.40	7,338	226,600	63.37	7,180	4	2,800	91	3	2,100	67
Stevens	14	222,800	66.58	7,417	213,500	66.58	7,107	7	7,100	238	4	2,200	72
Krause Dairy Feed	16	172,600	66.45	5,735	170,800	66.48	5,677	1	1,000	32	2	800	26
Syragold	15	148,900	59.81	4,453	137,800	59.80	4,120	4	8,200	246	4	2,900	87
Globe Creamery	18	123,800	65.36	4,046	115,600	65.40	3,780	4	6,700	216	3	1,500	50
Bufceco	8	48,800	61.56	1,502	43,000	62.23	1,338	3	5,100	143	1	700	21
Cream City Dairy	5	22,000	64.91	714	21,400	64.95	695	2	600	19	....	......	......
Boston Mixed	2	16,000	51.88	415	13,600	51.91	353	1	1,800	40	2	600	16
Amco Dairy	1	13,000	64.92	422	13,000	64.92	422	....	......	......	....	......	......
Monarch	2	10,000	55.80	279	8,800	55.91	246	1	1,200	33	....	......	......
Maroni	1	2,100	64.76	68	2,100	64.76	68	....	......	......	....	......	......
Jem Creamery	1	1,000	56.00	28	1,000	56.00	28	....	......	......	....	......	......
Twin Six	1	500	68.00	17	500	68.00	17	....	......	......	....	......	......
Kinds not found (higher protein)	1	38,300	60.05	1,150	38,300	60.05	1,150	....	......	......	....	......	......
Calf meal:													
Blatchford's	18	4,450	100.67	224	......	......	......	18	4,350	219	1	100	5
Purina	4	1,900	76.84	73	......	......	......	4	1,900	73	....	......	......
Ryde's	3	400	120.00	24	......	......	......	3	400	24	....	......	......
Kroker's	1	150	66.67	5	......	......	......	1	150	5	....	......	......
Sucrene	1	50	120.00	3	......	......	......	1	50	3	....	......	......
Calf Chow	1	50	120.00	3	......	......	......	1	50	3	....	......	......
Krause	1	50	160.09	4	......	......	......	1	50	4	....	......	......
Kinds not found	3	250	128.00	16	......	......	......	3	250	16	....	......	......
Gluten feed	39	220,800	59.12	6,527	211,700	59.19	6,265	11	6,800	199	8	2,300	63
Oilmeal	35	49,400	66.28	1,637	42,200	66.73	1,408	9	6,000	192	4	1,200	37
Cottonseed meal	14	21,300	68.26	727	20,500	68.10	698	5	700	25	1	100	4
Total purchased	....	5,069,100	$62.20	$157,661	4,692,940	$62.33	$146,245	....	311,100	$9,430	....	65,060	$1,986
Total concentrates	....	5,355,800	$61.81	$165,524	4,917,550	$62.01	$152,468	....	365,700	$10,865	....	72,550	$2,191

Broome County four years earlier, 82 per cent were unmixed and 18 per cent were compounded. Feed-manufacturing companies have made special efforts, thru agents and in advertising, to stimulate the use of compounded feeds. It is probable that the tendency among dairymen in most parts of the State is to use more of the compounded ready rations. The labor of mixing is thus dispensed with. Many dairymen buy in less than ton lots, for which some retailers make a charge of $2 per ton over ton-lot prices. But even with the extra labor and small-lot charges, equal nutriment can generally be purchased cheaper in by-products. Perhaps many have been influenced by convenience, constancy of dealers' supplies, and persuasive arguments.

Succulent feed

Silage was charged alike on all farms at $7 per ton (table 4). Of the 163 farms, 92, or 56.4 per cent, used silage. The quantity averaged 57 tons per farm for the farms using it. Small quantities of other succulent feeds were used. The average value of all succulent feed was $6.80 per ton.

Dry forage

The average value of hay was $19.63 per ton (table 5). Some straw and corn stover were used. The average value of these was $8.71 per ton. Of the total tons of home-grown dry forage used by cattle, hay constituted 89.8 per cent. Of the total hay, excluding mixed hay, 20 per cent was leguminous.

Pasture

Dairy cattle pastured 14,765 acres (an average of 3.04 acres per animal unit), in addition to meadow land pastured after hay was cut. The average value of pasture land was $38.77 per acre.

Pasture cost included the following items: 5 per cent interest on the average value of pasture land; the share of the total farm taxes chargeable to pasture; labor and materials in making and repairing pasture fences; cash paid for pasture; charge for pasturing meadows; and expenses for mowing, seeding, and fertilizing pastures. Receipts from stock taken in to pasture were deducted to get the net cost of pasturing the farmer's own stock. This charge was apportioned to the different classes of stock on the animal-unit basis according to the number of days pastured. Interest represented 51.7 per cent of the cost, and fence upkeep 17.9 per cent. Taxes averaged 0.8 per cent of the average value of the land.

The dates of turning the cattle out to pasture in the spring varied from May 1 to June 1, and of stabling in the fall with full barn rations from September 1 to November 15. The average date of turning out in the spring was May 13 and of stabling October 29, allowing a pasture period of 169 days.

The average acres of meadow land pastured after the hay was removed was 46 per farm. The charges given for use of these meadows averaged $65.70 per farm, or $1.43 per acre. Cattle pastured meadows an average of 31 days per farm pasturing. Thus the average charge was $2.10 per day for this feed. Labor in building temporary fences or in herding was

TABLE 4. SUCCULENT FEED USED BY 4136 COWS, 1410 HEIFERS, AND 230 HERD BULLS

Kind of feed	Total herds: Number of herds using	Total herds: Number of tons used	Total herds: Average price per ton	Total herds: Value	Cows: Number of tons used	Cows: Average price per ton	Cows: Value	Heifers: Number of herds using	Heifers: Number of tons used	Heifers: Value	Herd bulls: Number of herds using	Herd bulls: Number of tons used	Herd bulls: Value
Home-grown:													
Corn silage	92	5,260	$ 7.00	$36,820	4,736.1	$ 7.00	$33,153	54	435.7	$3,050	47	88.2	$617
Corn (green)	68	1,654.5	5.85	9,682	1,630	5.85	9,542	5	19	111	6	5.5	29
Sweet corn	2	45	3.67	165	43	3.70	159	..	......	......	1	2	6
Turnips and rutabagas	12	31.2	13.78	430	25	13.44	336	4	4.2	70	1	2	24
Potatoes	15	11.6	20.00	232	11.45	19.91	228	1	0.15	4	....	......	....
Mangels and beets	4	11.5	17.83	205	11.5	17.83	205	....	......	......	....	......	....
Millet	1	23	6.00	138	23	6.00	138	....	......	......	....	......	....
Oats	1	10	8.00	80	10	8.00	80	....	......	......	....	......	....
Oats and buckwheat	1	15	7.00	105	15	7.00	105	....	......	......	....	......	....
Oats, peas, and buckwheat	1	2	25.00	50	2	25.00	50	....	......	......	..	......	....
Alfalfa	6	38	10.74	408	37.5	10.67	400	1	0.5	8	....	......	....
Clover	7	104	6.51	677	103.75	6.51	675	....	......	......	1	0.25	2
Rowen	3	20.5	5.80	119	20.5	5.80	119	....	......	......	....	......	....
Total home-grown	...	7,226.3	$6.80	$49,111	6,668.8	$6.78	$45,190	....	459.55	$3,243	....	97.95	$678
Purchased:													
Skimmilk	5	3.7	$7.57	$28	....	....	......	5	3.7	$28	....	......	....
Corn silage	1	12	7.50	90	12	$7.50	$90	....	......	...	....	......	....
Total purchased	....	15.7	$7.52	$118	12	$7.50	$90	...	3.7	$28	....	......	....
Total succulent feed	....	7,242.0	$6.80	$49,229	6,680.8	$6.78	$45,280	....	463.25	$3,271	....	97.95	$678
Total succulent feed excepting skimmilk	....	7,238.3	$6.80	$49,201	6,680.8	$6.78	$45,280	....	459.55	$3,243	....	97.95	$678

TABLE 5. Dry Forage Used by 4136 Cows, 1410 Heifers, and 230 Herd Bulls

Kind of feed	Total herds				Cows			Heifers			Herd bulls		
	Number of herds using	Number of tons used	Average price per ton	Value	Number of tons used	Average price per ton	Value	Number of herds using	Number of tons used	Value	Number of herds using	Number of tons used	Value
Home-grown:													
Mixed hay	152	7,111	$19.61	$139,439	5,429.1	$19.54	$106,083	133	1,374.9	$27,347	127	307	$6,[illegible]
Timothy hay	66	1,695	20.19	34,215	1,296.55	20.31	26,335	51	340.45	6,710	31	58	1,17[illegible]
Clover hay	136	1,990	18.98	37,891	1,900.3	18.99	36,088	33	83.7	1,582	13	12	221
Clover hay (second cut)	5	35.5	21.55	765	34	21.62	735	1	1.5	30	....	....	
Alfalfa hay	20	198	24.10	4,771	190.3	24.07	4,580	4	7.7	191	....	....	
Alfalfa hay (second cut)	1	4	23.00	92	4	23.00	92	....	....	....	....	....	
Oat hay	16	121	16.93	2,049	116	16.89	1,959	3	5	90	....	....	
Oat and pea hay	4	27	17.26	466	26	17.15	446	1	1	20	....	....	
Wheat hay	1	2	17.00	34	2	17.00	34	....	....	....	....	....	
Rye hay	1	6	12.00	72	5.1	11.96	61	1	0.9	11	....	....	
Total hay	....	11,195.5	$19.63	$219,794	9,003.35	$19.59	$170,413	....	1,815.15	$35,081	....	377	$7,40[illegible]
Oat straw	103	506.5	$ 8.72	$4,415	417.025	$8.70	$3,630	47	78.1	$683	16	11.375	$10[illegible]
Oat and barley straw	2	28	6.36	178	12	6.50	78	2	14	87	2	2	1[illegible]
Wheat straw	3	8	14.50	116	7.1	13.80	98	1	0.9	18	....	....	
Corn stover	62	732.4	8.72	6,390	694	8.72	6,050	13	27.1	243	14	11.3	[illegible]
Total straw and stover	....	1,274.9	$8.71	$11,099	1,130.125	$8.72	$9,856	....	120.1	$1,031		24.675	$21[illegible]
Total home-grown	....	12,470.4	$18.52	$230,893	10,133.475	$18.38	$186,269	....	1,935.25	$37,012	....	401.675	$7,61[illegible]
Purchased:													
Mixed hay	41	287.45	$16.68	$4,796	281.75	$16.63	$4,686	1	4	$77	1	1.7	$[illegible]
Corn stover	1	6	5.00	30	6	5.00	30	....	....	...		....	
Total purchased	....	293.45	$16.45	$4,826	287.75	$16.39	$4,716	....	4	$77	....	1.7	$[illegible]
Total dry forage	....	12,763.85	$18.47	$235,719	10,421.225	$18.33	$190,985	....	1,939.25	$37,089	....	403.375	$7,645

included under labor, not in the charge for meadows. The cost of pasture was $11.35 per cattle unit for the season, or 6.72 cents per day. Excluding the charge for use of meadows, the cost was $9.25 per cattle unit, or 5.48 cents per day. In Broome County in 1915, with land that averaged $20.25 per acre, the cost was $4.83 per cattle unit, or 3.04 cents per day. No meadow charge was included there.

Statements were obtained from 152 farmers as to the amount of repairing of pasture fences in the year covered by the records, as compared with the normal for recent years. Of those reporting, 82, or 53.9 per cent, replied that the repairs in the record year were about as they had been for several years past. The average, however, was 121 per cent of normal, indicating that the attention to pasture fences was about one-fifth more than usual. The extremes were 10 per cent and 1000 per cent of normal.

A summary of pasture costs is given in table 6. The numbers of stock pastured, and the distribution of the cost of pasture, are given in table 7.

TABLE 6. COST OF PASTURE

(14,765 acres of pasture land valued at $572,399 = $38.77 per acre)

Items	Farms having expense	Cost
Interest at 5 per cent	163	$28,616
Taxes	163	4,613
Amount paid for pasture	76	2,000
Charge for pasturing meadows	149	9,789
Posts	148	2,877
Barbed wire	82	1,052
Woven wire	10	81
Staples	163	152
Grass seed	3	32
Fertilizer	1	54
Human labor:		
On fences	162	3,788
Mowing, reseeding, and fertilizing pastures	33	211
Other human labor	2	24
Horse labor:		
On fences	149	1,957
Mowing, reseeding, and fertilizing pastures	10	52
Other costs	1	6
Total	163	$55,304
Received for pasture	10	218
Difference (=cost of pasture)	163	$55,086

Feed and milk price ratios

The ratio of feed prices to milk prices gives some indication of the favorableness of the dairy business for making money. On the Herkimer County farms studied, the average price for milk per hundred pounds as produced was slightly less than the cost of 100 pounds of concentrates; on Broome County farms in 1915, it was 1.1 times the cost of 100 pounds of concentrates. It averaged 8.5 times the price of silage in Herkimer County and 6.6 times the price of silage in Broome County. It averaged

TABLE 7. Stock Pastured, and Distribution of Pasture Cost

Kind of stock	Number of farms pastur-ing	Number of animals pastured	Average number of days pastured per farm pastur-ing	Equiva-lent in animal units for entire season	Amount charged
Cows	163	4,139	169	4,139.0	$45,377
Heifers one year or over	143	671	169	193.5	3,488
Heifers under one year	117	554	158	228.9	2,953
Herd bulls	139	169	165	126.4	1,405
Bulls to be sold	2	2	132	1.5	9
Total cattle	....	5,535	....	4,689.3	$53,232
Animals units of other stock	26	70.5	84	31.5	$ 371
Horses	81	257	81	124.8	1,379
Colts	8	18	163	8.8	104
Total	....	345.5	....	165.1	$1,854

Acres of pasture per animal unit, 3.04.
Cost per cattle unit of farmer's own stock, $11.35.

slightly over three times the value of hay per 100 pounds in each of the regions. In each region, in the stabling period, the ratios of prices for milk produced to feed values were slightly higher than for the year. Compared with the ratios in Broome County, silage was cheap in Herkimer County, grain was relatively expensive, and hay was about the same. The charge for use of pasture was about twice as much in Herkimer County as in Broome County when the charge for use of meadows is excluded. Part of this greater cost was due to interest and taxes on pasture land, which is more valuable in Herkimer County, and part to increased fence charges, due to advance in cost of materials, higher prices for labor, and more than the normal amount of attention to fences.

The comparative data are given in table 8:

TABLE 8. Price Averages and Ratios for Broome and Herkimer Counties

	Broome County, 1915 (149 farms)	Herkimer County, 1919 (163 farms)
Per cent of pounds of concentrates purchased	96	94.6
Per cent of pounds of concentrates home-grown	4	5.4
Per cent of concentrates by-products	91	86.5
Per cent of concentrates unmixed	82.3	26.2
Per cent of concentrates compounded	17.7	73.8
Average price per ton of concentrates	$29.93	$61.81
Ratio of price of concentrates to price of hay per ton	1:0.35	1:0.32
Per cent of tons of hay fed cattle, purchased	1.0	2.5
Per cent of tons of hay, leguminous	4.1	17.5
Average price per ton of hay	$10.35	$19.56
Average price per ton of other dry forage	$5.49	$8.96

TABLE 8 (*concluded*)

	Broome County, 1915 (149 farms)	Herkimer County, 1919, (163 farms)
Average price per ton of silage	$5.00	$7.00
Average price per ton of other succulent feed	$3.51	$6.25
Average value of pasture land per acre	$20.25	$38.77
Per cent of total charge for use of pasture represented by interest	70.0	65.8
Per cent of total charge for use of pasture represented by fence upkeep	20.9	22.8
Per cent of total area in pasture	33.9	54.2
Cost of pasture per cattle unit for season, excluding charge for pasturing meadows	$4.83	$9.25
Ratio of price of concentrates per 100 pounds to price of milk	1:1.09	1:0.96
Ratio of price of silage per 100 pounds to price of milk	1:6.56	1:8.51
Ratio of price of hay per 100 pounds to price of milk	1:3.17	1:3.05
Ratio of price of concentrates per 100 pounds to average price received for milk in stabling period	1:1.21	1:1.12
Ratio of price of corn silage per 100 pounds to average price received for milk in stabling period	1:7.24	1:9.86
Ratio of price of hay per 100 pounds to average price received for milk in stabling period	1:3.50	1:3.53
Ratio of price of concentrates to average price of silage	1:0.17	1:0.11

Bedding

The bedding charge was apportioned to cows, heifers, and herd bulls on each farm. Most of this charge was for oat straw grown on the farm. Shavings and sawdust are usually purchased whenever it is necessary to buy bedding. The data are given in table 9:

TABLE 9. BEDDING

Kind of bedding	Total herds			Cows		Heifers		Herd bulls	
	Number of farms using	Amount (tons)	Value	Number of farms using	Value	Number of farms using	Value	Number of farms using	Value
Home-grown:									
Oat straw	135	656.5	$5,519.00	134	$4,133.00	101	$997	93	$389
Barley straw	1	6	18.00	1	9.00	1	6	1	3
Oat and barley straw	2	17	143.00	2	98.00	2	33	2	12
Wheat straw	5	12.5	84.00	5	78.00	2	4	1	2
Oat and spring-wheat straw	1	6	48.00	1	24.00	1	16	1	8
Hay	1	3	45.00	1	30.00	1	10	1	5
Sawdust	3	4.75	7.50	3	7.50	....	......	....	....
Tanbark and sawdust	1	2	20.00	1	15.00	1	5	....	....
Total home-grown	....	.....	$5,884.50	.	$4,394.50	....	$1,071	....	$419
Purchased:									
Straws	9	15.05	$148.00	9	$148.00	....	......	....	....
Shavings	21	1,089	428.00	21	399.00	4	$25	2	$4
Sawdust	23	92.5	185.50	23	182.50	1	2	1	1
Total purchased	...	....	$761.50	....	$729.50	....	$27	....	$5
Total bedding	....	....	$6,646.00	...	$5,124.00	....	$1,098	....	$424

Labor

No cost records of labor on these farms were available. The operators were asked to state a wage per hour that would represent what it would cost to hire a person equally efficient to do the work they were doing, and also to give rates for other classes of help. No differences were made between summer and winter rates.

The variation in the wages asked is shown in table 10:

TABLE 10. Variation in Wages Asked (Rates per Hour)

Value per hour (cents)	Class of labor			
	Operator	Operator's wife	Hired man	All other labor
7	....	....	....	1
7.5	....	....	....	1
10	....	....	....	3
13	....	....	1	....
15	....	1	1	15
18	....	....	2	....
20	....	11	7	27
22	....	....	2	....
23	....	1	1	....
25	2	25	23	28
26	....	....	1	....
27	....	....	1	....
28	1	....	5	3
30	25	32	25	32
31	....	....	....	1
33	4	....	....	....
35	25	11	2	11
40	52	11	4	6
45	10	1	....	2
50	35	9	1	3
60	2	....	....	....
70	2	....	....	....
75	1	....	....	....
80	1	....	....	....
90	1	....	....	....
Total	161	102	76	133

The classification of human labor is shown in tables 11 and 12. Of the work for which classification is shown in table 12, 51.8 per cent was performed by the operator, 11.7 per cent by the operator's wife, 16.3 per cent by the operator's children, and 20.2 per cent by other labor. This indicates a total of 79.8 per cent by the operator and his family. A milk price, to be fair, must reflect fair pay to these members of the family for their efforts. Low rewards for labor on the farm do not encourage the younger generations to remain.

The average rate at which labor was charged was 35 cents an hour, but for operators it was 41 cents, for operators' wives 32 cents, and for hired men 27 cents. The rates for the operators' daughters were about 5 cents less than for the sons.

TABLE 11. CLASSIFICATION OF HUMAN LABOR FOR COWS

	Hours	Value	Per cent of total hours	Average price charged per hour
Operator	334,071	$137,765	50.4	$0.41
Operator's wife	75,352	24,045	11.4	0.32
Operator's sons:				
10–15 years old	17,269	3,587	2.6	0.21
16–21 years old	27,792	7,912	4.2	0.28
Over 21 years old	44,573	14,067	6.7	0.32
Operator's daughters:				
10–15 years old	5,020	923	0.8	0.18
16–21 years old	4,415	1,013	0.6	0.23
Over 21 years old	6,301	1,715	1.0	0.27
Hired men	117,694	32,362	17.8	0.27
Hired women	5,806	1,355	0.9	0.23
Other help	23,693	6,515	3.6	0.27
Total	661,986	$231,259	100.0	$0.35

TABLE 12. TOTAL HUMAN LABOR FOR ALL CATTLE

	Pasture period		Winter period		Total	
	Farms	Hours	Farms	Hours	Hours	Value
Labor for cows:						
Milking:						
Operator	160	72,924	160	62,197	135,121	....
Operator's wife	96	41,756	60	23,813	65,569	....
Operator's sons:						
10–15 years	17	8,840	15	5,737	14,577	....
16–21 years	21	8,582	20	7,155	15,737	....
Over 21 years	28	12,145	29	10,699	22,844	....
Operator's daughters:						
10–15 years	9	3,634	3	1,344	4,978	....
16–21 years	7	2,513	5	1,902	4,415	....
Over 21 years	9	4,446	5	1,855	6,301	....
Hired men	68	35,217	61	24,065	59,282	....
Hired women	8	2,953	7	2,661	5,614	....
Hired boys	4	1,642	3	838	2,480	....
Other help (unclassified)	17	8,458	11	5,136	13,594	....
Feeding and care of cattle, and care of utensils and products:						
Operator	149	36,179	149	147,836	184,015	....
Operator's wife	60	4,593	54	5,068	9,661	....
Operator's sons:						
16–21 years	1	632	4	3,162	3,794	....
Over 21 years	5	1,135	7	6,788	7,923	....
Hired men	20	4,635	23	26,886	31,521	....
Operator's brothers	1	252	1	1,182	1,434	....
Other labor on cows:						
Operator	.....	3,082	.....	11,853	14,935	....
Operator's wife	.....	75	.....	47	122	....
Operator's sons:						
10–15 years	.....	768	.....	1,924	2,692	....
16–21 years	.....	559	.....	7,702	8,261	....

TABLE 12 (*concluded*)

	Pasture period		Winter period		Total	
	Farms	Hours	Farms	Hours	Hours	Value
Labor for cows (*cont'd*):						
Other labor on cows (*cont'd*):						
Operator's sons (*cont'd*):						
Over 21 years	....	840	...	12,966	13,806	....
Operator's daughters, 10–15 years	....	42	.....	......	42	......
Hired men	.....	1,600	.....	25,291	26,891	....
Hired women	....	192	.....	......	192	......
Hired boys	.....	1,171	....	1,881	3,052	......
Other help (unclassified)	.....	......	....	3,133	3,133	....
Total labor for cows	.....	258,865	.....	403,121	661,986	$231,259
Labor for heifers (149 farms)					41,145	16,881
Labor for herd bulls (148 farms)					11,188	4,555
Labor for veal calves (4 farms)					63	24
Total human labor					714,382	$252,719

Of the total time on cows, 53 per cent was spent in milking, 36 per cent in feeding and in care of cows, product, and utensils, and 11 per cent in other labor (table 13).

TABLE 13. Distribution of Labor on Cows, by Operations

	Total hours	Per cent of total
Milking	350,512	53
Feeding, and care of cows, product, and utensils	238,348	36
Other labor	73,126	11
Total	661,986	100

Horse labor was charged at the rates believed by operators to represent the cost of this item. The average was 20 cents per hour. The hours and the value of horse labor are given in table 14.

TABLE 14. Horse Labor

	Farms	Hours	Value
Horse labor for cows	158	38,619	$7,715
Horse labor for heifers	62	1,668	330
Horse labor for herd bulls	53	352	67
Total horse labor	....	40,639	$8,112

Hauling milk

Charges for hauling milk consisted of the value of human and horse time, the charge for the use of automobile and truck, and cash paid for hauling. Charges for wagons and other equipment used in delivering the milk were included under use of equipment.

The human-labor charge represented 47.4 per cent of the total cost, the horse-labor charge 42.9 per cent, the automobile charge 0.9 per cent, and the cash paid 8.8 per cent, of the total cost of hauling milk from farms to milk plants (table 15). Of the total human time spent, 22.4 per cent was in cooperation with neighbors. When milk is hauled in cooperation, the chores may be finished earlier in the day and much more extra work accomplished before noon than when the farmer breaks into the morning by hauling his own milk. Of the human time spent in hauling, 81.6 per cent was represented by time of operators. The advantages of operators going with milk are that business can be attended to, and the chore work can be delegated to others. On many farms the operators must do both.

TABLE 15. CHARGES FOR HAULING AND DELIVERING TO THE MILK STATIONS 201,676 HUNDREDWEIGHT OF MILK

	Total		Value		Time spent hauling independently			Time spent hauling in cooperation		
	Number of farms	Hours spent	Total	Per cent	Number of farms	Hours spent	Value	Number of farms	Hours spent	Value
Human labor:										
Operator	132	67,396	...	..	103	51,896	...	42	15,500	...
Hired man	12	5,555	...	...	9	4,339	...	4	1,216	...
Operator's son	15	7,589	...	..	11	6,404	...	4	1,185	...
Operator's father	1	216	...	.	...	.	...	1	216	...
Operator's wife	2	337	.	..	2	337	.	...	...	...
Operator's children	6	1,181	..	..	5	815	..	1	366	...
Operator's brother	1	336	...		1	336	..	...	...	...
Total human labor	.	82,610	$32,013	47.4	.	64,127	$24,237	..	18,483	$7,776
Horse labor	125	143,322	29,016	42.9	118	108,184	22,057	50	35,138	6,959
Use of automobiles and trucks	7	...	617	0.9	7	.	617	...	...	...
Cash paid for hauling regularly	43		5,940	8.8	..	..	...	...	...	...
Total cost	..	...	$67,586	100.0		...	$46,911		...	$14,735
Amount received for hauling milk	4		$818				..	.	...	...
Net cost of hauling milk	...	...	$66,768			.	..	.	...	...

Use of buildings

Values at the beginning and at the end of the year, of the dairy cattle barns, yards, buildings for storing equipment used for cattle, milk houses, tubs, vats, ice houses, and pump houses used for dairy cattle, are given in table 16. The values of silos have been omitted, since the charge for silage covers the use of the silo.

TABLE 16. VALUE OF BUILDINGS

	May 1, 1918		May 1, 1919	
	Farms	Value	Farms	Value
Dairy and cattle barns, yards, buildings for storing equipment used for cattle	163	$251,106	163	$252,167
Milk houses	71	8,609	72	8,709
Milk tubs	1	6	1	6
Milk vats	1	20	1	20
Ice houses	38	3,985	38	3,985
Share of pump houses	2	35	2	35
Total	....	$263,761	....	$264,922

Average value, $264,341
Increase in value, $1,161
Average value per farm, $1,622

The average of these values was $1622 per farm. The charges for building repairs and additions during the year totaled $9245 (table 17). The depreciation on buildings was $8084, or 3.1 per cent of the average valuation.

The charge for use of buildings was distributed to cows, heifers, and herd bulls in the proportion that each represented of the total number of cattle units.

TABLE 17. CHARGES FOR USE OF BUILDINGS

	Number of farms	Cost
New buildings and building repairs:		
Purchased lumber	51	$2,215
Shingles	15	183
Roofing	17	962
Hardware	1	1
Paint	2	149
Glass	84	225
Sand	9	39
Gravel	3	4
Cement	21	390
Stanchions	4	238
Materials from farm:		
Sand and gravel	1	8
Lumber	2	48
New planking	4	182
Logs	1	45
Water buckets	1	100
Additions	1	400
Silos	2	717
Windows	4	51
Glass and windows	1	10
Siding	1	70
Doors	1	40
Iron posts	1	25
Patching and painting	1	25
Sawing lumber	1	1

TABLE 17 (*concluded*)

	Number of farms	Cost
New buildings and building repairs (*continued*):		
Labor:		
Hired	24	$1,107
Farm	37	1,203
Horse	20	701
Board of labor	10	106
Total	....	$ 9,245
Interest on $264,341 at 5 per cent	....	13,217
Insurance	....	640
Taxes	....	2,827
Decreased value	....	1,339
Total	....	$27,268
Less increase in value	....	2,500
Net charge for use of buildings	....	$24,768

Apportionment of cost

	Number of farms having expense	Amount charged
Cows	163	$20,519
Heifers	160	3,421
Herd bulls	153	828
Total	....	$24,768

There are arguments in favor of arranging the barn so that the animals will head outward. The most important of these is that such an arrangement allows driving thru to load manure. Where manure is hauled daily, this saves labor. Other arguments are that milking machines can be used to better advantage, less time is required in cleaning the barn and in bedding the cattle, there is practically no occasion during the pasture season to go in front of the cattle except to fasten and unfasten stanchions, and hay can come down chutes at the side of the mows.

Some arguments in favor of heading the animals inward are that with this arrangement feeding requires less labor, and litter carriers can be used to better advantage. In dairy sections the arrangement on the majority of farms is for the animals to head outward.

On the farms studied, 85.7 per cent headed outward but only 70.8 per cent of the barns were arranged to be driven thru (table 18). There were plank floors in 36.4 per cent and straight stanchions in 91.4 per cent of the barns. On 85.1 per cent of the farms the cattle were turned into the yard or driven to pasture for water. Of the total number, 8.7 per cent used buckets.

TABLE 18. Barn Arrangement and Facilities

Arrangement	Number of farms	Per cent of total
Cattle heading inward	23	14.3
Cattle heading outward	138	85.7
Driving thru basement possible	115	70.8
Manure wheeled out	40	24.8
Manure pitched thru window	3	1.9
Manure carrier used	4	2.5
Concrete floor	100	61.7
Plank floor	59	36.4
Concrete floor partly covered with plank	3	1.9
Straight stanchions	148	91.4
Swing stanchions	14	8.6
Water in yard	124	77.0
Water buckets	14	8.7
Other arrangements for water in barn	10	6.2
Water in pasture	13	8.1

Use of equipment

The value of the different kinds of equipment used with dairy cattle, and the purchases of and repairs to equipment, are shown in table 19.

TABLE 19. Value of Equipment, Purchases, and Repairs on Equipment

	May 1, 1918		May 1, 1919		Purchased equipment		Repairs on equipment	
	Number of farms	Value of equipment	Number of farms	Value of equipment	Number of farms	Value	Number of farms	Value
Milk cans	160	$8,651.00	161	$7,927.00	16	$ 330 00	73	$ 248.40
Coolers	60	387.00	64	393 00	4	14 00		......
Testers, bottles, and so forth	1	12 00	2	19.00	1	7.00		......
Milk or feed scales	64	445 00	64	445.00		...		....
Separators	27	1,322 00	29	1,443.00	2	130.00	1	3.50
Churns and butter workers	45	272 00	45	272.00	.	.....	.	....
Milk pails and strainers	163	745 50	163	736.50	104	239.45	4	9.75
Milking machines	14	4,024 00	18	5,592.00	4	1,798 00	11	238.00
Milk wagons	141	6,132.00	153	6,632.00	14	858 00	97	1,069.50
Share of farm automobile	9	1,450.00	10	2,050.00	1	750 00	7	192.00
Water pumps	6	308.00	6	323 00		..	1	33.00
Gasoline or steam engines	15	1,650.00	16	2,069 00	2	464 00	3	79.00
Feed grinders	3	117.00	4	157.00	2	40.50	..	....
Water tanks	75	1,611.00	77	1,627.00	2	55.00	3	10.00
Water heaters	1	40.00	1	40 00	.	....	...	....
Share of other water system	143	18,194.00	144	18,574.00	.	..	25	748.40
Share of lighting system	11	945.00	13	1,055.00	2	110.00	1	20.00
Ice tools	35	237.00	36	317.00	1	90.00	1	4.00
Feed trucks	3	12.00	3	12.00	.	...	...	....
Litter carriers	4	205.00	4	205.00	.	.....	..	....
Wheelbarrows	105	324.00	118	408.00	18	101.75	1	1.00
Clipping machines	78	521.00	86	589.00	11	86.00	37	86.25
Whitewashing outfits	35	306.00	36	316.00	3	17.00	..	....
Milking tubes, milk-fever outfits, and so forth	8	16.00	8	16.00	.	.	1	3.00
Baskets	93	150.50	94	147.10	40	67.05		......
Brooms	157	262.00	157	262.00	136	284.90	..	....
Forks	154	603 00	154	694.00	103	227.84	...	....
Shovels	147	247.00	147	248.00	120	218.45	2	1.80
Sprayers	28	39.50	32	59.50	23	42.03	....	....

TABLE 19 (*concluded*)

	May 1, 1918		May 1, 1919		Purchased equipment		Repairs on equipment	
	Number of farms	Value of equipment	Number of farms	Value of equipment	Number of farms	Value	Number of farms	Value
Currycombs and brushes...	102	$126 50	103	$126.50	65	$ 62.45	1	$ 0.50
Rope...........	3	5.00	3	5.00	5	5.10	.	......
Halters.........	2	4 00	2	4.00		......	..	....
Bull staffs and rings.....	8	8.00	10	11.00	9	7.75	...	.....
Lanterns.......	123	241.50	123	241.50	41	65.55	13	12.00
Calf pails.......	24	26.50	25	29.50	10	11.60	....	......
Milking stools.......	2	2.00	2	2.00	1	1.25	.	......
Globes......	1	2.00	1	2.00	31	28.10	..	....
Water troughs...	45	933.00	46	945.00	1	16.00	...	....
Water rams........	5	106.00	5	106.00	....	......	1	6.35
Automobile trucks....		.....	1	740.00	1	740.00	....	......
Water buckets.......	7	732.00	8	782.00	1	50.00	2	22.00
Motors............	1	50.00	1	150.00	1	100.00	1	4.00
Rent for whitewashing outfit	.	....	.	..	8	20.00	...	....
Ensilage shovel......	1	2.00	1	2.00	1	1.35	...	....
Kicker chains.......	1	2.00	1	2.00		....	...	....
Chains.........	1	1.00	1	1.00	4	6.45	.	....
Hand clippers ..	1	3.00	1	3.00	.	......	..	......
Kerosene engines....	1	150.00	2	269.00	1	119.00	1	2.50
Metal strainers	.	..	1	2.00	1	2.25	..	.....
Use of spray pump..	..			.	1	1.50	.	....
Cheese cans.	1	9.00	1	9.00		....	.	...
Milk carts......		.	1	5.00	1	5.00		.
Hire of clipping machine.		...	.	....	1	2.50		...
Human labor....	.	..		....		...	13	208 32
Rent of cans.....		..	..	..	5	27.00	.	....
Miscellaneous...		10.00			.	....		..
Total....		$51,732 00	..	$56,065.60	..	$7,203.82	..	$3,003.27

The charges for the use of equipment (table 20) include interest at 5 per cent on the average value at the beginning and at the end of the year, cost of equipment purchased during the year, repairs on equipment, and decreased value less any increase in value. This cost was apportioned to different parts of the enterprise for each farm. The depreciation on equipment was $5873, or 10.9 per cent of the average valuation.

On May 1, 1919, 18, or 11 per cent of the 163 farms, were using milking machines. On February 1, 1918, there were eight counties in the State in which 5 per cent or more of the farmers were using milking machines.[2]

TABLE 20. CHARGES FOR USE OF EQUIPMENT

	Number of farms having expense	Cost
Interest	163	$2,702
Equipment purchased	160	7,204
Repairs	141	3,003
Total	....	$12,909
Less increase in value	....	4,334
Net charge for use of equipment	....	$8,575

[2] Census of the agricultural resources of New York, 1919.

TABLE 20 (concluded)

Apportionment of cost

	Number of farms having expense	Amount charged
Cows	163	$7,517
Heifers	150	850
Herd bulls	120	208
Total	163	$8,575

These were: Jefferson, 8 per cent; Chenango, 7.6 per cent; Delaware, 7.2 per cent; St. Lawrence, 6.2 per cent; Madison, 6 per cent; Lewis, 5.1 per cent; Cattaraugus, 5.1 per cent; and Putnam 5.1 per cent. The average for the State was 2.7 per cent.

The shortage of labor has hastened the introduction of mechanical milkers. With 15 cows or less, the investment in a milking machine and the cost of operating it are high per cow. Thus the one-man dairy, where the machine is much needed, can least afford it. Not only are the investment and the cost of operation high per cow in a small dairy, but very little time is saved, if any, by the use of a machine in such herds. A dairy farm, to be most efficient, must be large enough to support a two- or three-man dairy, so that labor-saving equipment can be afforded. Many dairy farms are so small that they support only a one-man herd. The owner of such a farm cannot afford help, and consequently is tied closely to his work.

Adjusting the size of the farm business to the most effective unit often requires capital which the farmer does not have. Frequently he is of such age that he does not wish to make use of the credit necessary to increase his area or remodel his buildings so as to keep more cattle. In many cases boys have left the farm, and dependable help is scarce, and there is no tenant house for the hired man. These conditions often make the farmer who is out of debt decide to reduce his business rather than increase it. Some farms are operated by young men who are heavily in debt and not in a position to incur further indebtedness in order to purchase cattle. All of these situations tend to keep the dairy enterprise smaller than the unit for most efficient operation. Usually the size of the herd is limited by the size of the farm. Any increase in the size of the herd in most cases means the farming of more land. Occasionally this may be done by renting or by purchase.

Interest

Interest at 5 per cent was charged on the average value of cattle, and on the investment in feed and supplies kept on hand for cattle (tables 21 and 22). The charges for interest on use of buildings, use of equipment, and use of pasture have been included under those items. Probably the rate used should have been 6 per cent.

TABLE 21. INTEREST ON AVERAGE VALUE OF CATTLE

	Total average number from inventory	Total average value from inventory	Interest at 5 per cent	Number of farms having expense
Cows	4,135.5	$588,219	$29,412	163
Heifers	1,407.0	65,754	3,292	160
Herd bulls	231.5	17,440	874	152
Veal calves	4.5	58	1	1
Total	5,778.5	$671,471	$33,579	....

TABLE 22. INTEREST ON AVERAGE VALUE OF FEED AND SUPPLIES KEPT ON HAND

Average value of feed and supplies on hand	Total herds		Cows		Heifers		Herd bulls	
	Number of farms having expense	Interest at 5 per cent	Number of farms having expense	Amount charged	Number of farms having expense	Amount charged	Number of farms having expense	Amount charged
$133,641	163	$6,684	163	$5,419	155	$1,025	115	$240

Miscellaneous costs

There are many expenses that must be classed as miscellaneous costs. The most important are: salt, condimental feeds, veterinary fees, tax on and keep of a cow dog, telephone, fly repellents, grinding feed, dues to the Dairymen's League, and herd and dairy inspection. The data on miscellaneous costs for the herds studied are given in table 23.

Jt is sometimes said that the sucessful dairyman is the one who is his own veterinarian, who keeps down the numerous small items of expense, and so forth. The miscellaneous costs amounted to only 6 cents per 100 pounds of milk. While it is important to be economical in all phases of dairy operations, the most important items of expense are feed and labor. Many of the miscellaneous costs, such as disinfectants, fly killers, records and papers, and veterinary expenses, indicate the degree of careful attention which a dairyman gives to his herd. Such expenses often result in increased income.

TABLE 23. Miscellaneous Costs

Item	Total herds		Cows		Heifers		Herd bulls		Veal calves and bulls to be sold	
	Number of farms having expense	Cost	Number of farms having expense	Cost	Number of farms having expense	Cost	Number of farms having expense	Cost	Number of farms having expense	Cost
Insurance on cattle	98	$ 237.81	98	$ 230.81	7	$ 7.00	......	......	......	......
Taxes	2	2.00	1	1.00	1	1.00	......	......	......	......
Condimental feeds	103	990.20	103	965.20	3	23.00	2	$ 2.00	......	......
Salt	161	1,097.15	161	918.80	107	143.35	47	35.00	......	......
Vaseline and other medicines	126	382.75	126	376.75	......	......	1	6.00	......	......
Disinfectants	58	199.85	58	188.85	1	1.00	2	10.00	......	......
Tuberculin testing	5	27.00	5	25.00	1	2.00	......	......	......	......
Dehorning	24	59.28	16	44.50	8	14.53	1	0.25	......	......
Veterinary fees	75	1,093.00	71	1,017.00	5	34.00	3	42.00	......	......
Louse killers	42	93.95	42	90.95	3	3.00	......	......	......	......
Lime	74	108.86	74	108.86	......	......	......	......	......	......
Fly killers	118	499.25	118	474.90	19	19.55	7	4.80	......	......
Kerosene	131	303.45	131	301.95	2	1.50	......	......	......	......
Carbide	10	104.50	10	94.50	6	8.00	2	2.00	......	......
Electric lights	8	121.00	8	101.00	4	16.00	4	4.00	......	......
Gasoline	14	159.56	14	156.16	3	3.40	......	......	......	......
Oil	13	25.10	13	25.10	......	......	......	......	......	......
Batteries for engine	10	43.60	10	43.60	......	......	......	......	......	......
Fuel for dairy	1	14.00	1	10.00	1	3.00	1	1.00	......	......
Towels, suits, strainers, muslin	123	207.65	123	207.65	......	......	......	......	......	......
Grinding feed	43	316.78	40	263.53	15	49.70	4	3.55	......	......
Amount paid for hauling feed, and so forth	5	124.00	5	115.00	1	9.00	......	......	......	......
Amount paid for ice	25	255.38	25	255.38	......	......	......	......	......	......
Sawdust for ice	9	45.00	9	45.00	......	......	......	......	......	......
Association dues	44	78.85	44	78.85	......	......	......	......	......	......
Dairy papers	79	129.50	79	129.50	......	......	......	......	......	......
Herd books or other records	1	5.00	1	2.00	1	2.00	1	1.00	......	......

TABLE 23 (*concluded*)

Item	Total herds		Cows		Heifers		Herd bulls		Veal calves and bulls to be sold	
	Number of farms having expense	Cost	Number of farms having expense	Cost	Number of farms having expense	Cost	Number of farms having expense	Cost	Number of farms having expense	Cost
Registration fees	6	$ 40.50	....	....	5	$22.50	2	$14.00	1	$4.00
Transfer fees	2	2.50	....	....	....	....	....	....	2	2.50
Telephone	84	572.00	84	$ 571.00	1	1.00	....	....	....	....
Railroad fares	2	32.00	2	32.00	....	....	....	....	....	....
Expense to Little Falls	13	21.47	13	21.47	....	....	....	....	....	....
Dairy inspection	87	309.10	87	309.10	....	....	....	....	....	....
Dairymen's League dues	84	849.87	84	849.87	....	....	....	....	....	....
Making cheese	7	67.06	7	67.06	....	....	....	....	....	....
Cow dogs purchased	2	11.00	2	11.00	....	....	....	....	....	....
Keep of cow dogs	101	2,905.00	101	2,905.00	....	....	....	....	....	....
Tax on cow dogs	101	246.75	101	246.75	....	....	....	....	....	....
Driving cows	1	1.00	1	1.00	....	....	....	....	....	....
Use of truck	1	20.00	1	20.00	....	....	....	....	....	....
Use of automobile	3	35.00	3	35.00	....	....	....	....	....	....
Vaccination	3	11.50	....	....	3	11.50	....	....	....	....
Insurance on feed	1	12.00	1	12.00	....	....	....	....	....	....
Milk tickets	1	14.00	1	14.00	....	....	....	....	....	....
Rent of cows	1	100.00	1	100.00	....	....	....	....	....	....
Labor on ice	1	6.00	1	6.00	....	....	....	....	....	....
City water	1	10.00	1	7.00	1	2.00	1	1.00	....	....
Total	....	$11,991.22	....	$11,480.09	....	$378.03	....	$126.60	....	$6.50
Breeding fees	....	....	....	....	....	....	10	$165.00	....	....
Rent of bull	....	....	....	....	....	....	2	30.00	....	....

RETURNS FOR ALL CATTLE

The returns from dairy cattle are grouped as follows: (1) milk and milk products, (2) appreciation on cattle, (3) manure recovered, and (4) miscellaneous returns.

Milk and milk products

Milk sold wholesale

The number of dairymen delivering to various plants is shown in table 24. Very little shifting from one plant to another occurred. During the period from May 16 to May 31, 1918, sixteen producers delivered 203,918 pounds of milk valued at $5682, and from September 16 to September 30 fifteen producers delivered 87,189 pounds valued at $2684, for all of which the producers received no pay owing to the failure of the company handling their milk. This is 1.4 per cent of the total value of milk delivered by the 163 farmers. The data are given in table 25.

TABLE 24. NUMBER OF DAIRYMEN DELIVERING TO VARIOUS PLANTS

	Location of plant	Number of dairymen delivering milk
International Milk Products Co.; Nestlé Food Co., part year	Middleville	39
Borden's Condensed Milk Co.	Newport	36
Borden's Farm Products Co.	Fort Plain	1
T. O. Smith's Sons	East Bridge	29
J. E. Rosasco	Poland	17
Newport Milk and Cream Co., May 1 to September 30, 1918; N. A. Van Son, October 1 to November 16, 1918; J. E. Rosasco, November 17, 1918, to March 31, 1919; Max Blum, April 1 to April 30, 1919	Newport	13
Sanitary Milk Co.	Herkimer	6
E. D. Potter	Herkimer	4
Lovier and Putnam	Herkimer	1
Levy Dairy Co.	Middleville	3
Little Falls Dairy Co.	Little Falls	1
Levy part year, Nestlé part year	Middleville	1
Levy part year, Borden's part year	Middleville, Newport	1
Levy part year, retail part year	Middleville	1
Borden's part year, International and Nestlé part year	Newport, Middleville	1
Borden's part year, Newport Milk and Cream Co. part year	Newport	3
International part year, Borden's part year	Middleville, Newport	1
International and Nestlé part year, cheese factory part year	Middleville	3
Borden's part year, cheese factory part year	Newport	1
Borden's part year, Rosasco part year	Newport	1
Total		163

TABLE 25. RETURNS FROM MILK SOLD WHOLESALE

	Number of farms selling	Pounds of milk sold	Per cent of total milk sold	Pounds of fat in milk	Average per cent of butterfat	Average value per 100 pounds of milk sold	Per cent of yearly average price on 3.5-per-cent-butterfat basis	Total value of milk sold	Per cent of total value
1918:									
May	163	2,397,758	11.9	80,544	3.36	$2.55	80	$61,123	10.2
June	163	2,841,810	14.1	94,698	3.33	1.90	61	54,097	9.9
July	163	2,431,905	12.1	83,243	3.42	2.39	75	58,088	9.6
August	163	2,087,181	10.3	75,445	3.61	2.88	88	60,148	10.0
September	163	1,682,493	8.3	64,194	3.82	3.16	94	53,231	8.8
October	163	1,304,967	6.5	51,265	3.93	3.88	115	50,571	8.4
November	161	786,470	3.9	31,725	4.03	4.13	122	32,482	5.4
December	161	862,305	4.3	33,134	3.84	4.32	130	37,247	6.2
1919:									
January	155	895,004	4.4	33,257	3.72	4.07	123	36,463	6.1
February	155	1,112,845	5.5	39,486	3.55	3.69	113	41,059	6.8
March	160	1,665,998	8.3	56,192	3.37	3.37	106	56,067	9.3
April	163	2,098,853	10.4	69,466	3.31	2.92	93	61,236	10.2
Total milk sold wholesale, including that not paid for	......	20,167,589	100.0	712,649	3.53	$2.98	100	$601,812	100.0
Milk sold wholesale, not paid for:									
May 16–31	......	203,918	......	6,926	......	....	....	$5,682	....
September 16–30	......	87,189	......	3,164	......	....	....	2,684	....
Total not paid for	......	291,107	......	10,090	......	....	....	$8,366	....
Total milk paid for	......	19,876,482	......	702,559	......	....	....	$593,446	....

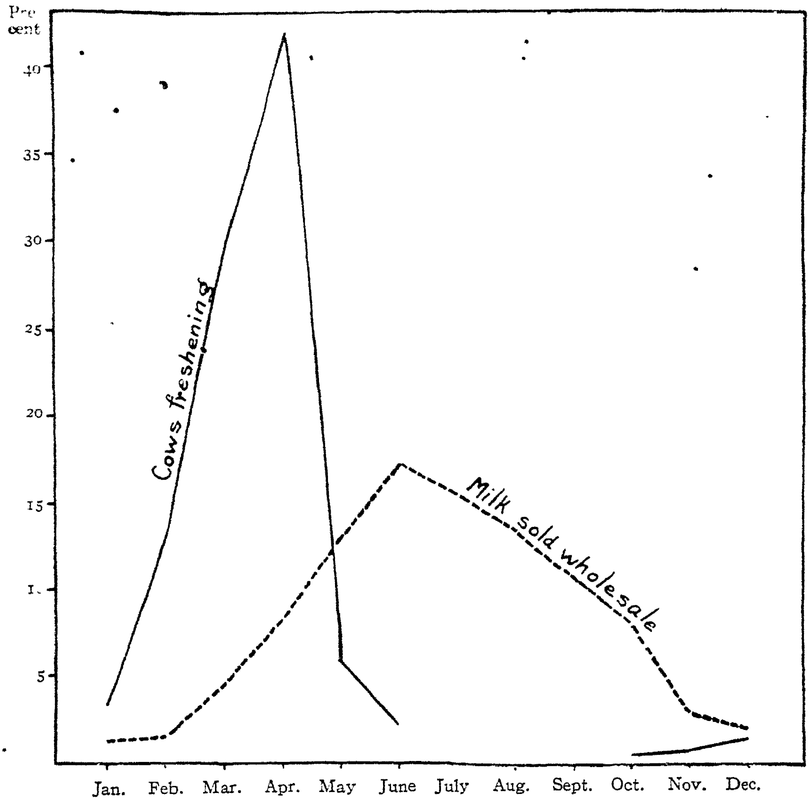

FIGURE 2. RELATION BETWEEN TIME OF FRESHENING AND DISTRIBUTION OF PRODUCTION, FOR HERDS PRODUCING LESS THAN 25 PER CENT OF THEIR MILK IN THE SIX MONTHS NOVEMBER TO APRIL

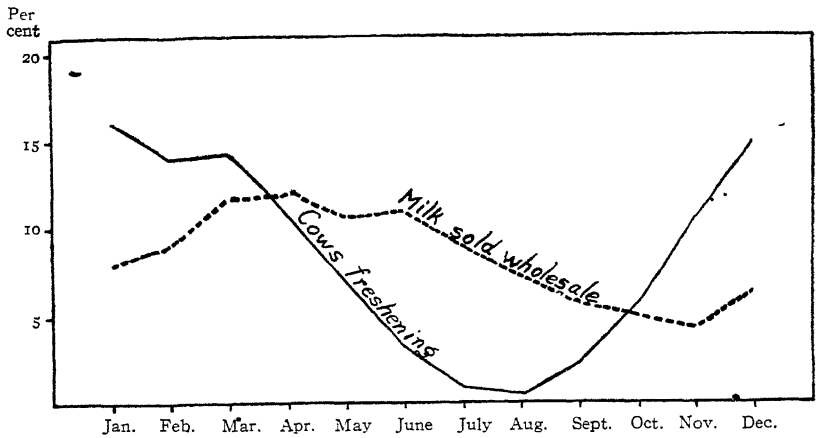

FIGURE 3. RELATION BETWEEN TIME OF FRESHENING AND DISTRIBUTION OF PRODUCTION, FOR HERDS PRODUCING MORE THAN 45 PER CENT OF THEIR MILK IN THE SIX MONTHS NOVEMBER TO APRIL

The leaning toward the summer system in the farms studied is shown by the proportion of milk produced in the summer period (figures 2 and 3). In the six winter, or stabling, months, November to April inclusive, 36.8 per cent of the wholesale milk was produced, and in the summer months 63.2 per cent, or nearly two-thirds.

The fact that a much larger proportion of the milk is produced in summer, when prices are lower than in winter, for the State as a whole and especially for the dairies here studied, means that a simple average of the twelve monthly prices of milk of a given fat content is higher than the average price received by farmers. For example, the weighted average test of milk for the 163 farms was 3.53 per cent, and the weighted average price was $2.98 per 100 pounds. The average of the twelve monthly prices, which were for milk ranging in test from 3.33 to 4.03 per cent, was $3.27, and the average of the twelve monthly prices on a basis of 3.53-per-cent milk, which was the average test for the year, was $3.24 per 100 pounds. These prices are, respectively, 29 and 26 cents, or 9.7 and 8.7 per cent, higher than the actual average price of $2.98.

In Broome County, New York, in 1915, the weighted average price of milk which tested 4 per cent, was $1.64 per 100 pounds. The simple average of the twelve monthly prices received was $1.70, a difference of only 6 cents per 100 pounds. Relatively more of the milk was produced in winter in this area than in Herkimer County.

The average butterfat test was 3.53 per cent for the year, but varied from 3.31 per cent in April to 4.03 per cent in November. A difference of 4 cents per 100 pounds of milk for each 0.1 per cent of butterfat was allowed by purchasers of milk in each of the months of the year under study.

Milk retailed and milk products sold

Five farmers sold some butter, three made some cheese, and six retailed part of the milk (table 26). The total value of milk products sold was $3132.

TABLE 26. MILK PRODUCTS SOLD

	Number of farms	Pounds of product	Pounds of fat	Price	Total value
Butter	5	658	559	$0.64	$ 422
Cheese	3	1,164	422	0.17	198
Milk retailed	6	56,824	1,971	4.42	2,512
Total	......	....	2,952	....	$3,132

Milk and milk products used

The average amount of milk used per operator's family was 2613 pounds. On eight farms milk was furnished to the hired help, the average amount per family being 2212 pounds. Milk used in the households was credited to cows at 20 cents less per 100 pounds than the average price received for all milk for the year, to allow for hauling charges. On 46 of the farms, or 28.2 per cent, some butter was made for family consumption. The average amount used per family making and using butter was 74.6 pounds. Most of the skimmilk was fed to the hogs. The data are given in table 27.

TABLE 27. Milk and Its Products Used on Farms

	Number of farms	Pounds of product	Pounds of fat	Price	Total value
Milk used:					
Family	163	425,926	15,623	$ 2.80	$11,910
Hired men	8	17,698	648	2.77	491
Milk products used:					
Skimmilk:					
Family	5	8,069	...	0.41	33
Hogs	31	53,233	.....	0.37	198
Poultry	2	2,255	....	0.31	
Buttermilk:					
Family	4	582	.....	1.20	
Hogs	4	910	.....	0.55	
Butter, family use	46	3,430	2,916	0.55	1,872
Cream, family use	4	401	80	20.00	80
Cottage cheese, family use	1	100	.....	5.00	5
Total milk and its products used, except that fed to cattle	......	....	19,267	......	$14,608
Equivalent in pounds of milk*	.....	511,112	......	......	......
Milk used:					
Heifers	135	443,361	16,233	$3.35	$14,848
Bulls to be kept	54	52,769	1,943	3.33	1,757
Calves to be vealed	58	99,509	3,658	3.17	3,156
Milk products used:					
Skimmilk:					
Cows	2	2,650	.....	0.23	6
Heifers	16	46,538	.....	0.34	159
Bulls to be kept	4	1,884	......	0.42	8
Calves to be vealed	1	500	.....	0.20	1
Total milk and its products fed to cattle	.....	....	21,834	......	$19,935
Equivalent in pounds of milk*	..	647,211	......	......	....
Total equivalent in pounds of milk excluding buttermilk	.	1,158,323	41,101	......	....

* Excluding buttermilk.

Appreciation on cattle

Appreciation and depreciation were calculated in the following manner: Cattle were charged with the first inventory and all purchases of dairy cattle. From this amount were deducted the credits for cattle sold or used, hides, and the second inventory.

Cows were charged with the inventory at the beginning, cows purchased, and heifers that became cows. From this amount was deducted the sum of the values of cows sold or slaughtered, cow hides, and the inventory at the end.

Heifers were charged with the first inventories, heifers purchased, and value at birth of heifers born during the year. They were credited with

TABLE 28. APPRECIATION AND DEPRECIATION ON CATTLE

	Total herds		Cows			Heifers					
						Under 1 year old			1 year old or over		
	Total number	Total value	Number of farms	Number of cows	Value	Number of farms	Number of heifers	Value	Number of farms	Number of heifers	Value
On hand May 1, 1918	5,701	$653,891	163	4,105	$579,235	146	719	$18,263	145	602	$40,943
Purchased during year	632	56,425	90	394	46,355	29	75	767	25	87	5,085
Born during year	. . .	.	. . . . .	. . . . . .	. .	135	535	3,851	. . . . .	. .	. . . . . .
Heifers that became cows	450	50,100	142	450	50,100	. . .	. . . . .	. . . .	. . . .		. . . .
Total	. . . .	$760,416	. . .	. . . . .	$675,690	. . .	. . . .	$22,881	($68,909)		$46,028
Slaughtered or sold for slaughter	3,405	$ 46,949	129	472	$ 24,577	1	1	$ 9	4	4	$ 237
Sold for breeding and production	377	22,649	50	220	19,455	29	96	721	9	30	1,480
Died or killed by accident	212	.	64	91	. . .	21	35	. .	16	20	. .
Hides sold	189	1,081	55	75	696	7	14	30	10	15	79
Heifers that became cows	450	50,100	.	. . . .	. . . . .	. . . .	. . . . .	. . . . .	142	450	50,100
Deacons	114	244	.	. . . . .	. . . . .	. . . .	. . . . .	. . . . .	. . . .	. . .	. . . .
Dead calf hides	227	88	. .	. . .	. . . .	. . . .	. . . . .	. . . .	. . .	. . .	.
On hand May 1, 1919	5,856	689,051	163	4,166	597,203	133	490	12,072	151	943	60,229
Total	. . .	$810,162	.	. . .	$641,031	. . . .	. . . .	$12,832	($124,957)		$112,125
Appreciation	. . . .	*$30,617		. . . .		. . . . . .	. . . . .	. . . .	$56,048		. . . .
Depreciation	.	. . . .	. . .	. . . . . .	$33,759	. . . . .	. . . . .	. . . . . .	. . . .	. . . .	. . . . . .

* The difference between the charges and credits to cattle here is $49,746. When $332 for deacon and dead calf hides, and $18,797 for other calves, is deducted, the resulting net appreciation on cattle is $30,617.

TABLE 28 (*concluded*)

	Herd bulls									Veals						Bull calves to be sold		
	Bull calves to be kept			Bulls 1 to 2 years old			Bulls over 2 years old			Calves fatted			Calves not fatted					
	Number of farms	Number of bulls	Value	Number of farms	Number of bulls	Value	Number of farms	Number of bulls	Value	Number of farms	Number of calves	Value	Number of farms	Number of calves	Value	Number of farms	Number of bull calves	Value
On hand May 1, 1918	51	53	$1,224	74	70	$5,652	83	84	$ 8,562	1	2	$ 12	....	..	..	....		....
Purchased during year	24	26	823	20	21	1,100	28	20	2,295	...		....		..				
Born during year	44	49	320	...	.	...	..	.	...	163	2,908	14,279		...	...	13	25	$341
Heifers that became cows	.		...	.	..	...	.		..	...	...	...	.		..	.	.	...
Total		...	$2,373	($10,982)		$6,752	.	..	$10,857	..	....	$14,291	..	.		.		$341
Slaughtered or sold for slaughter		....	..	7	7	$ 390	66	66	$ 5,106	50	144	$2,589	163	2,706	$13,816	2	5	$225
Sold for breeding and production	1	1	$ 0	1	1	60	10	10	811	..	...	.....	.	.	.	10	10	113
Died or killed by accident	2	2	....	1	1	.		.	...	...	....	..	27	53		1	1	..
Hides sold	1	1	4	2	2	11	4	4	38	.	...	.....	48	77	222	1	1	1
Heifers that became cows	...	..	....	....	..	..			....	...	..	...	..	...	....		...	....
Deacons	..	..	....	...	..	...	.	.	..	....	..	....	..	..	...	.	...	.
Dead calf hides	.	.	...	..	.	...			..	.	..	..	...		....		...	.
On hand May 1, 1919	62	66	2,020	64	66	4,065	117	118	13,358	6	7	104			.			.
Total	..	....	$2,033	($25,872)		$4,526			$19,313	..	...	$2,693	($16,731)		$14,038	.	.	$339
Appreciation	...	....	....	$5,800		....	...	...	...	...	....	...	$2,440		....	...	..	.
Depreciation	..	...	....	....	....	..	....	..	...	...	....	...	....	....	....	...		$2

heifers sold and slaughtered, value at time of freshening of heifers that freshened during the year for the first time, heifer hides, and inventories at the end.

Herd bulls were charged with the inventories at the beginning, herd bulls purchased, and value at birth of bull calves born during the year and to be kept for future service. They were credited with herd bulls sold and slaughtered, hides, and the inventories at the end.

Veals and bulls to be sold were charged with the inventories at the beginning, purchases, and value at birth of veal calves and of bulls to be sold that were born during the year. They were credited with veals and bulls sold or slaughtered, hides, and the inventories at the end.

The depreciation on cows was $33,759, or 5.7 per cent of their average value. The appreciation on heifers was $56,048, which is $79.68 per cattle unit, or 8.5 per cent of their average value. The appreciation on herd bulls was $5890, and on veals and bulls to be sold $2438. The net appreciation on cattle, found by deducting the depreciation on cows from the appreciation on other cattle, was $30,617, or 4.6 per cent of the average cattle valuation.

A summary of the appreciation and depreciation on each part of the enterprise is given in table 28.

Calves born during the year were charged to heifers, herd bulls, and veals and bulls to be sold, at their value at birth, and were credited to cows, but were not included in returns from cattle.

Of the live calves born, 14.7 per cent were heifers started, 34.2 per cent were heifers vealed or sold to be vealed, 1.3 per cent were bulls to be kept, 45.9 per cent were bulls to be vealed or sold for vealing, and 3.2 per cent were deaconed (table 29). Of the cows freshening, 3.8 per cent aborted and 2.1 per cent gave birth to dead calves not premature.

The average value of live calves at birth was $5.24. Heifers to be raised averaged $7.20, bulls to be raised $6.65, heifers to be vealed $4.86, and bulls to be vealed $4.94. Calves deaconed averaged $2.14 each.

TABLE 29. NUMBER OF CALVES BORN DURING THE YEAR AND VALUE AT BIRTH

	Number of farms	Number	Per cent of live calves	Value of each at birth	Total value
Heifers vealed or to be vealed	154	1,241	34.2	$ 4.86	$6,037
Heifers raised or to be raised	135	535	14.7	7.20	3,851
Bulls vealed or to be vealed	163	1,667	45.9	4.94	8,242
Bulls to be kept	44	49	1.3	6.65	326
Other bulls sold or to be sold	13	25	0.7	13.64	341
Calves born dead, aborted	67	148	......	....	13*
Calves born dead, not premature	60	79	......	....	75*
Heifers deaconed	20	46	1.3	2.02	93*
Bulls deaconed	22	68	1.9	2.22	151*
Live calves	......	3,631	100.0	$5.24	$19,041
Total value, including value of hides and carcasses	......	......	......	....	$19,129

* Value of hides and carcasses.

On 46 farms there were vealed 245 calves from what the farmers considered to be good cows. On 142 farms there were 450 heifers, valued at $50,100, which freshened in that year for the first time.

A comparison of results for Broome County, New York, in 1915 with those for this region is given in table 30. In Broome County 44 per cent of the live calves were raised, while in Herkimer County only 16.7 were raised. The difference may be due partly to the fact that in Herkimer County the general practice is to raise a smaller proportion of the calves, or that the price level was double the pre-war level and this discouraged the raising of calves.

The average price received for calves in Herkimer County was two and one-quarter times that received in Broome County.

TABLE 30. Proportion of Calves Raised, Broome and Herkimer Counties

	Broome County, 149 farms			Herkimer County, 163 farms		
	Number of farms	Per cent of live calves	Value of each at birth	Number of farms	Per cent of live calves	Value of each at birth
Heifers to be raised or sold....	140	37.4	$3.05	135	14.7	$ 7.20
Bulls to be kept............	50	2.8	4.19	44	1.3	6.55
Bulls sold or to be sold.......	42	3.8	4.15	13	0.7	13.64
Calves vealed or sold to be vealed	137	47.8	1.76	163	80.1	4.91
Calves deaconed..........	51	8.2	1.07	22	3.2	2.14
	....	100.0	$2.34	....	100.0	$5.24

Manure recovered

The average quantity of cattle manure recovered for use on crop land was 7.4 tons per cattle unit, and the average value per ton at the barn was $2.60.

The credit for manure was apportioned to cows, to heifers, and to herd bulls according to the average inventory of cattle units (table 31). The value of manure per cattle unit was $19.34.

TABLE 31. Manure Recovered

Total herds		Cows		Heifers		Herd bulls	
Tons	Value	Tons	Value	Tons	Value	Tons	Value
37,243.0	$96,832	30,836.8	$80,173	5,173.6	$13,455	1,232.6	$3,204

As in other pursuits, so in agriculture, the point where an additional increment of cost or of quantity fails to yield an increased return corresponding to that resulting from a previously added increment, is a point

upon which much of good economic practice hinges. From experimental results it is apparent that the greater value of increased crops for each ton of manure used is obtained when the applications are relatively light, and that with each additional ton added after a light application the returns are diminished. In order to get the most out of manure, light applications are usually to be recommended. However, where crop land is limited and manure is plentiful, as in most dairy regions, much heavier applications than would permit of the most efficient use of manure are necessary.

On the farms studied, there were 30.7 cattle units, besides the horses and other stock, per farm. Since the acres of crops averaged 68 per farm, this is an average of 2.2 acres of crops per cattle unit. The usual rotation in this section is corn silage one year, oats one year, hay about three years. If 13.6 acres, or one-fifth of the crop area, were manured each year, the cattle manure would provide for an application of 16.7 tons per acre. This would average 3.3 tons per acre per year, or 16.7 tons per acre every five years. The other manure would increase this somewhat, but it is probable that the meadows are cut more than three years on an average.

According to the State Census previously referred to (page 22), 15.1 per cent of the farms used manure spreaders. The counties in which the largest proportion of farms used spreaders were: Genesee, 36.3 per cent; Seneca, 35.5 per cent; Orleans, 30.6 per cent; Livingston, 28.7 per cent; Monroe, 25 per cent. In the intensive dairy counties the proportion of farms using manure spreaders was approximately one-third of these western New York counties. One reason for this is that in the above-named counties much of the land is level, but probably a more important reason is that little stock is kept in these general farming and fruit regions and it is desired to make the manure go as far as possible by thin spreading. In dairy regions, crop land is so limited and manure so plentiful that there is little difficulty in getting over all the land in each rotation with a very heavy application.

Miscellaneous returns

Feed bags sold constitute the chief miscellaneous receipts for cattle (table 32).

TABLE 32. MISCELLANEOUS RETURNS

Item	Number of farms having receipt	Total amount received	Credited to	
			Cows	Herd bulls
Insurance	1	$ 50	$ 50	....
Breeding fees	2	48	....	$48
Feed bags	136	2,264	2,264	....
Cement bags	7	25	25	....
Other receipts	1	11	11	....
Total	....	$2,398	$2,350	$48

SUMMARY OF COSTS AND RETURNS

The costs and returns for each part of the enterprise given in the previous tables are summarized in table 33.

TABLE 33. Summary of Costs and Returns

	Total herds		Cows		Heifers		Herd bulls		Veals and bulls to be sold	
	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value
Costs:										
Grain	5,355,800 pounds	$165,524	4,917,550 pounds	$152,468	365,700 pounds	$10,865	72,550 pounds	$2,101		
Succulent feeds (except skimmilk)	7,238.3 tons	49,201	6,680.8 tons	45,280	459.55 tons	3,243	97.95 tons	678		
Dry forage	12,763.85 tons	235,719	10,421.225 tons	190,085	1,939.25 tons	37,089	403.375 tons	7,645		
Skimmilk, purchased	3.7 tons	28			3.7 tons	28				
Skimmilk, farm			2,650 pounds	6	46,538 pound	159	1,884 pounds	8	500 pounds	$ 1
Whole milk, farm					443,361 pound	14,848	52,769 pounds	1,757	99,509 pounds	3,156
Pasture	14,765 acres	53,232		45,377		6,441		1,405		9
Bedding		6,646		5,124		1,098		424		
Human labor	714,382 hours	252,719	661,986 hours	231,259	41,145 hours	16,881	11,188 hours	4,555	63 hours	24
Horse labor	40,639 hours	8,112	38,619 hours	7,715	1,668 hours	330	352 hours	67		
Hauling milk		66,768		66,768						
Use of buildings		24,768		20,519		3,421		828		
Use of equipment		8,575		7,517		850		208		
Interest on cattle		33,579		29,412		3,292		874		1
Interest on feed and supplies		6,684		5,419		1,025		240		
Breeding fees		195						105		
Cost of keeping herd bulls				12,060						
Depreciation on cows				33,759						
Miscellaneous		11,991		11,180		378		127		6
Total costs		$923,741		$865,148		$99,948		$21,202		$3,107
Returns:										
Other than milk sold wholesale:										
Milk products sold		$ 620		$ 620						
Milk and its products used on the farm, except that fed to cattle		14,608		14,608						
Milk and its products fed to cattle				19,935						
Appreciation on cattle		30,617				$56,048		$5,890		$2,438
Calves and calf hides				10,129						
Manure	37,243 tons	96,832	30,836 8 tons	80,173	5,173 6 tons	$13,455	1,232.6 tons	3,204		
Miscellaneous		2,398		2,350				48		
Milk sold retail	56,824 pounds	2,512	56,824 pounds	2,512						
Total returns, excluding milk sold wholesale		$147,587		$130,327						
Milk sold wholesale*	20,167,589 pounds	$593,446	20,167,589 pounds	$593,446						
Total returns		$741,033		$732,773		$69,503		$9,142		$2,438
Loss		$182,708		$132,375		$30,445		$12,060		$759
•Costs less returns other than milk sold wholesale (=cost of milk at market)		$776,154		$725,821						
Cost per hundred pounds sold		$3.85		$3.60						

* Excluding milk not paid for.

COST OF PRODUCING MILK AND BUTTERFAT

The cost of production is reported both as herd cost and as cow cost for milk sold wholesale. In computing the herd cost, all returns from dairy cattle except milk sold wholesale were deducted from all dairy-cattle costs. In computing the cow cost, charges and credits to cows only were considered, heifers being charged at their value at freshening, and the cost of keeping herd bulls being charged to cows.

The herd cost of production was $3.85 per 100 pounds of milk, or $1.09 per pound of butterfat (table 34). The cow cost of production was $3.60

TABLE 34. SUMMARY OF COST OF PRODUCING AND DELIVERING TO MARKET 201,676 HUNDREDWEIGHT OF MILK CONTAINING 712,649 POUNDS OF BUTTERFAT, 163 FARMS

	Herd cost (4136 cows, 1407 heifers, 232 herd bulls, 4 veals)		Cow cost (4136 cows)	
	Per 100 pounds of milk sold	Per pound of butterfat	Per 100 pounds of milk sold	Per pound of butterfat
Costs:				
Grain	$0.82	$0.23	$0.76	$0.22
Succulent feeds	0.25	0.07	0.22	0.06
Dry forage	1.17	0.33	0.95	0.27
Pasture	0.26	0.08	0.22	0.06
Bedding	0.03	0.01	0.02	0.01
Human labor	1.25	0.35	1.15	0.32
Horse labor	0.04	0.01	0.04	0.01
Hauling milk	0.33	0.09	0.33	0.09
Use of buildings	0.12	0.04	0.10	0.03
Use of equipment	0.04	0.01	0.04	0.01
Interest on cattle	0.17	0.05	0.14	0.04
Interest on feed and supplies	0.04	0.01	0.03	0.01
Cost of keeping herd bulls	....	....	0.06	0.02
Depreciation on cows	....	....	0.17	0.05
Miscellaneous	0.06	0.02	0.06	0.02
Total costs	$4.58	$1.30	$4.29	$1.22
Returns other than milk sold wholesale:				
Milk sold retail, and milk products sold	$0.02	$0.01	$0.02	$0.01
Milk and its products used on farm	0.07	0.02	0.07	0.02
Milk and its products fed to cattle	....	....	0.10	0.03
Appreciation	0.15	0.04	....	....
Calves and calf hides	....	....	0.09	0.03
Manure	0.48	0.14	0.40	0.11
Miscellaneous	0.01	....	0.01	....
Total	$0.73	$0.21	$0.69	$0.20
Cost of milk or butterfat at market	$3.85	$1.09	$3.60	$1.02
Average price of all milk sold wholesale	2.98	0.84	2.98	0.84
Difference	0.87	0.25	0.62	0.18
Average price received for milk sold wholesale, paid for	2.94	0.83	2.94	0.83
Loss	0.91	0.26	0.66	0.19

for milk and $1.02 per pound of fat. Feed excluding the charge for pasture, and human labor, represented 79 per cent of the net cow cost of producing all milk.

The cost of production includes a charge for delivering to the receiving stations. The average price received for all milk sold wholesale for which the producers were paid, was $2.94 per 100 pounds, or 83 cents per pound of fat. The loss, therefore, was 91 cents per 100 pounds of milk on the herd basis, or 66 cents on the cow basis. The loss per pound of fat was 26 cents on the herd basis, or 19 cents on the cow basis. The large loss on heifers resulted in a herd cost per 100 pounds of milk 25 cents higher than the cow cost. One of the reasons for this loss was that the milk charge to heifers was more than one-fourth of the appreciation on them.

CAPITAL INVESTED FOR MILK PRODUCTION

The average investment for milk production was $10,284 per farm, $405.29 per cow, $7.83 per hundred pounds of milk, and $2.22 for each pound of butterfat produced (table 35). Slightly over one-third of the capital was invested in cows, one-third in pasture land, and less than one-third in herd bulls, other cattle, equipment, and feed and supplies. This investment does not include the value of crop land or any land other than pasture, the value of farming implements, the value of livestock excepting cattle, or the value of silos and buildings other than parts of the barns used for cattle. The sum of these values, added to the capital shown in table 35, would represent the total farm capital. Most of these farms sell little or no cash crops, milk and cattle being the entire output.

TABLE 35. CAPITAL INVESTED FOR THE PRODUCTION OF 21,395,026 POUNDS OF MILK CONTAINING 756,702 POUNDS OF BUTTERFAT, 163 FARMS

	Total capital	Per cent	Per farm	Per cow	Per 100 pounds of milk produced	Per pound of butterfat produced
Cows	$588,219	35.1	$3,609	$142.22	$2.75	$0.78
Herd bulls	17,440	1.0	107	4.22	0.08	0.02
Other cattle	65,812	3.9	404	15.91	0.31	0.09
Buildings	264,341	15.8	1,622	63.91	1.24	0.35
Equipment	53,899	3.2	331	13.03	0.25	0.07
Pasture land	552,931	33.0	3,392	133.69	2.58	0.73
Feed and supplies	133,641	8.0	819	32.31	0.62	0.18
Total	$1,676,283	100.0	$10,284	$405.29	$7.83	$2.22
Interest at 5 per cent	$83,814	......	$514	$20.26	$0.39	$0.11

The efficiency of the dairy cow in converting rough feeds into human food is generally acknowledged. The contribution to the city food supply per dollar invested and per hour spent, which is a fair indication of the high degree of efficiency of the dairyman, is not so generally appreciated.

For each dollar invested for milk-production purposes, there was produced 12 pounds, or 5.6 quarts, of milk. For each hour spent in milk-production operations on these farms, there was sold for city use 27.1

pounds, or 12.6 quarts, of milk. After other costs were met, therefore, the labor reward of these producers was 1.4 cents per quart. These 12.6 quarts of milk contained at least 8505 calories of energy. There were 12.5 hours per day per farm spent in milk-production operations.

The daily contribution per farm to the city food supply, therefore, was 106,312 calories. If it is assumed that the average man at moderate work required 3250 calories of energy per day, then the daily contribution per farm was as much energy as 33 men require. The rewards for such contribution should take account of the present and the more important future necessity of the service.

Occasionally some one with impossible ideas suggests that the State should control or direct the milk supply from start to finish — its production, its transportation, and its distribution. Such recommendations are usually based on the ill-conceived and erroneous notions that the methods of production and of distribution that now exist and the animals now employed are inefficient. The facts are that all these are quite efficient.

COMPARATIVE PRICES IN HERKIMER AND BROOME COUNTIES

The Bureau of Labor Statistics of the United States Department of Labor publishes index numbers of wholesale prices of groups of commodities and of all commodities. The groups are farm products, feed, clothes and clothing, fuel and lighting, metals and metal products, building materials, chemicals and drugs, house-furnishing goods, and miscellaneous. Each commodity is assigned an influence proportionate to its importance in the country's markets. The price indices of all commodities by months for the two fiscal periods covered by the milk surveys in Broome and Herkimer Counties, respectively, compared with the year 1913 as 100, were as shown in table 36.

TABLE 36. PRICE INDEX NUMBERS FOR FISCAL PERIODS, MAY TO APRIL INCLUSIVE, 1914–15 AND 1918–19, COMPARED WITH 1913 AS 100. ALL COMMODITIES*

	1914–15	1918–19
May	98	190
June	98	193
July	99	198
August	102	202
September	103	207
October	99	204
November	98	206
December	97	206
January	98	203
February	100	197
March	99	201
April	99	203
Average	99	201

*United States Bureau of Labor Statistics. Monthly Labor Review, vol. 6, no. 2, February, 1918, p. 105; Monthly Labor Review, vol. 12, no. 1, January, 1921, p. 90–91.

Prices of all commodities in the United States averaged slightly less in 1914–15 than in 1913, but in 1918–19 were 2.01 times, or about double, the 1913 prices. A comparison of feed, labor, milk, cows, and other

values for the Broome and Herkimer regions, calculated by dividing the actual prices that prevailed by the index numbers for the same years, is shown in table 37. The results may be considered as the purchasing power of the thing considered. For example, the average price received for milk in the Broome region was $1.64 per 100 pounds. The purchasing

TABLE 37. Comparative Prices for Broome and Herkimer Counties

	Broome County, 1914–15 (149 farms)		Herkimer County, 1918–19 (163 farms)	
	Actual price	Divided by index number of all commodities (99)	Actual price	Divided by index number of all commodities (201)
Average value of cows per head	$64 70	$65.35	$142.24	$70.77
Average value of heifers one year old or over	34.80	35.15	63.04	31.36
Average value of heifers under one year	13.70	13 84	25.09	12.48
Appreciation on heifers per cattle unit	43.54	43.98	79.68	39.64
Appreciation on herd per cattle unit	10 41	10.52	6.11	3.04
Value of concentrates per ton	29 93	30.23	61.81	30.75
Value of silage per ton	5.00	5.05	7.00	3.48
Value of dry forage per ton	9 62	9.72	18.47	9.19
Average wages per hour, human time	0.14	0 14	0.35	0.17
Average value of horse labor per hour	0.15	0.15	0.20	0.10
Value of manure per ton	1.25	1 26	2.60	1.29
Value of calves at birth	2.34	2 36	5.24	2.61
Cost of milk production (herd cost)	1.70	1 72	3.85	1.92
Price of milk per 100 pounds	1.64	1.66	2.98	1.48

power was $1.66. That is, in 1914–15, 100 pounds of milk would buy, on the average, $1.66 worth of all commodities at prices which prevailed for these commodities in 1913. The average price received for milk in the Herkimer region was $2.98 per 100 pounds. The purchasing power, found by dividing the price index of 201 into $2.98, was $1.48. That is, milk in the Herkimer region in 1918–19 would not buy as much of all commodities at the prices for that year, as milk in Broome County would in 1914–15 at the prices of that time. The purchasing power was less, so that, while many consumers believed that because they were paying double the price for milk in bottles the farmer was getting unduly rich, it is plain that when he bought labor, feed, clothing, and building materials, he could not buy as much with the money as he could before the war. The farmer might have received twice as much per hour, but living costs were also double.

BREEDS

The majority of herds were grade Holstein. Six were classed as grade Ayrshire, and there were twenty-one others in which grade Ayrshires were of importance. The total numbers of registered animals were: 59 cows, or 1.4 per cent of the total number; 27 heifers, or 1.9 per cent;

and 43 herd bulls, or 18.5 per cent. Of the registered cows, 54 were Holsteins and 5 were Ayrshires. There were also 5 Holsteins eligible to registry. Of the registered heifers, 26 were Holsteins and 1 was Ayrshire. Of the registered herd bulls, 37 were Holsteins, 3 were Ayrshires, and 3 were Guernseys. Among the herd bulls there were also 20 Holsteins and 1 Ayrshire eligible to registry.

WEIGHT

The more level the pasture land, the more effectively will large cows graze. If the pastures are steep, very large cows will not search for feed as readily as will smaller, more active animals. On the upland farms, on the average, the animals are smaller. Young stock, and young cows, and small cows, and small breeds, make the most effective use of very steep, rugged pastures, because of their activity. But the efficient use of winter feed must be considered also. Large mature cows of a large breed require less labor and other expense for the value of their product, and usually make more effective use of barn feed, than do small young cows. It is probable that under ordinary farm conditions the medium-sized cow in a herd is fed more nearly to the capacity in winter which is most profitable for her size, than is the very large cow. These facts argue for the medium-sized cow under ordinary conditions.

The average weight of calves at birth was 71 pounds, of heifers twelve months old 392 pounds, of heifers twenty-four months old 653 pounds, and of cows 936 pounds (table 38). Calves averaged at birth 7.6 per cent of the average weight of mature cows, at twelve months 42 per cent, and at twenty-four months 69.9 per cent. The average estimated weights of herds were given, not the weights of individual animals. The gain in weight from birth to twelve months of age averaged 321 pounds, from twelve to twenty-four months 261 pounds, and from twenty-four months to maturity 283 pounds. The average age of the animals was not obtained.

TABLE 38. WEIGHTS OF ANIMALS

	Per cent of milk produced in six months November to April inclusive				
	Less than 25	From 25 to 35	From 35 to 45	More than 45	All herds
	Pounds	Pounds	Pounds	Pounds	Pounds
Average weight of calves at birth	68	70	73	69	71
Average weight of heifers at 12 months	355	398	390	408	392
Average weight of heifers at 24 months	628	660	650	664	653
Average weight of cows	915	931	946	939	936

The variation in weight estimates given by the farmers is shown in table 39. The majority of estimates for cows were 800, 850, 900, 950, or 1000 pounds; for heifers twenty-four months old, 500, 600, 700, or 800 pounds; and for heifers twelve months old, 250, 300, 350, 400, 450, or 500 pounds. The estimates of weights of calves at birth were of more uniform distribution.

TABLE 39. Variation in Weights of Animals

Cows		Heifers two years old		Heifers one year old		Calves at birth	
Average weight (pounds)	Number of farms	Average weight (pounds)	Number of farms	Average weight (pounds)	Number of farms	Average weight (pounds)	Number of farms
600	1	400	3	200	5	40	1
700	4	450	3	225	1	45	1
750	8	500	16	250	11	50	12
800	13	550	11	275	2	60	16
850	12	575	1	300	30	65	17
875	3	600	29	350	16	70	41
900	34	650	13	370	2	75	46
950	19	660	1	375	1	80	15
975	1	670	2	400	35	85	6
980	1	675	2	450	21	90	7
1,000	47	700	46	470	1	100	1
1,050	8	725	1	475	1	......	....
1,075	1	750	8	500	20	......	....
1,100	4	800	18	550	4	......	....
1,150	2	850	1	565	1	......	....
1,200	4	900	3	580	1	......	....
1,300	1	....	....	600	6	......	....
....	....	....	....	700	1	......	....
936	163	653	158	392	159	71	163

SEASON OF MILK PRODUCTION

For the milk producer, the year carries two seasons that cause a wide difference in costs — summer and winter. In summer, pastures furnish a relatively cheap source of feed, which takes the place of practically all roughage and most of the grain. In winter, feeding which is very expensive in comparison with pasture is necessary.

The concentrates, succulent feed, and dry forage used by cows in the pasture period, in the winter period, and when dry, are given in tables 40, 41, and 42.

The average number of days that cows were dry was 64. It was assumed that the number of cows freshening each month were dry for this average number of days immediately preceding the fifteenth of the month. The number of days that cows were dry in the winter period was thus obtained.

An average of $88 worth of concentrates per farm were used in the pasture period. The kinds used were about the same as in winter.

Cows when dry used 5.8 per cent of the total pounds of concentrates used by cows, 8.8 per cent of the total tons of succulent feed, and 26.9 per cent of the total tons of dry forage. A large proportion of the concentrates used by dry cows were the low-protein feeds.

The records were divided into four groups according to the proportion of the milk sold wholesale that was produced in the six stabling months, November to April inclusive. The groups comprised 20 farms producing

TABLE 40. CONCENTRATES USED BY 4136 COWS

Kind of feed	In pasture period			In winter period			When dry		
	Number of herds using	Number of pounds used	Value	Number of herds using	Number of pounds used	Value	Number of herds using	Number of pounds used	Value
Home-grown:									
Oats	3	4,900	$141	46	135,060	$3,787	9	9,100	$263
Corn	......	....	....	15	34,050	1,120	3	8,100	263
Barley	......	....	....	6	26,200	533	1	1,000	17
Oats and barley	......	....	....	2	19,800	513	1	1,000	31
Wheat bran	......	....	....	3	3,500	103	1	300	8
Oats and peas	......	....	....	1	1,000	25	......	....	....
Buckwheat	......	....	....	1	100	1	......	....	....
Total home-grown	......	4,900	$141	......	219,710	$6,082	......	19,500	$581
Purchased:									
Ground oats	1	1,500	$ 44	35	181,300	$4,835	13	12,500	$ 343
Cornmeal	......	....	....	41	87,800	2,906	8	9,600	336
Corn and oats	......	....	....	5	51,500	1,560	3	4,600	140
Barley feed	2	9,000	229	12	25,200	694	1	900	27
Hominy	1	200	6	9	21,600	698	3	15,400	497
Oats and barley	......	....	....	3	14,800	380	1	2,000	60
Wheat bran	5	12,200	277	52	141,800	3,592	25	57,900	1,536
Wheat feed	7	15,000	394	33	70,700	1,842	11	21,300	540
Wheat middlings	4	8,700	221	14	27,800	771	3	3,100	82
Cottonseed feed	......	....	....	1	3,000	75	......	....	....
Molasses and molasses feeds:									
H. O. molasses feed	......	....	....	10	53,700	1,544	3	2,100	62
Molasses	1	6,000	159	6	23,500	677	1	800	22
H. O. milk feed	......	....	....	4	20,000	544	1	2,000	54
H. O. stock feed	......	....	....	1	2,800	78	......	....	....
Purina Cow Chow	4	47,100	1,531	10	56,940	1,716	1	12,200	366
Mormilk	1	5,000	160	8	84,400	2,685	1	2,300	74

International Ready Ration	......	....	....	1	65,300	1,779	......	....	....
International Climax Feed	......	....	....	4	44,900	1,135	2	800	21
Faramel	......	....	....	1	3,800	125	1	200	7
International Stock Feed	1	4,000	134	2	4,200	121	......	....	....
Mixed feeds:									
Schumacher	2	19,500	563	24	124,100	3,571	7	12,700	367
Portage Stock	......	....	....	1	5,200	143	1	3,200	88
Arcady Stock	......	....	....	2	7,700	194	......	....	....
Grandin's Mixed Feed	......	....	....	1	3,300	84	1	3,200	82
Badger's	......	....	....	2	3,500	104	......	....	....
Buffalo Mixed	......	....	....	1	2,000	55	......	....	....
Lucky Strike	......	....	....	2	1,200	35	......	....	....
Dairy Feed	......	....	....	1	500	16	......	....	....
Kinds not found (low protein)	1	200	6	1	7,700	185	1	900	22
Larro Feed	19	164,200	5,186	54	1,055,600	33,337	20	38,600	1,220
Union Grains	10	61,300	2,067	64	785,700	26,694	14	25,000	838
Unicorn	2	6,000	189	15	71,100	2,352	3	1,600	55
Big Q	2	31,000	960	27	195,600	6,220	4	4,100	125
Stevens	1	5,500	181	14	208,000	6,926	6	7,600	256
Krause Dairy Feed	3	35,300	1,171	16	135,500	4,506	2	2,000	66
Syragold	2	7,000	220	14	130,800	3,900	4	4,900	147
Globe Creamery	1	2,000	60	19	113,600	3,720	4	2,400	77
Bufceco	......	....	....	6	43,000	1,338	......	....	....
Cream City Dairy	......	....	....	5	21,400	695	2	1,600	50
Boston Mixed	......	....	....	2	13,600	353	2	3,000	82
Amco Dairy	......	....	....	1	13,000	422	......	....	....
Monarch	......	....	....	2	8,800	246	1	200	5
Maroni	......	....	....	1	2,100	68	......	....	....
Jem Creamery	......	....	....	1	1,000	28	......	....	....
Twin Six	......	....	....	1	500	17	......	....	....
Kinds not found (higher protein)	......	....	....	1	38,300	1,150	1	700	21
Gluten feed	7	16,300	475	38	195,400	5,790	4	2,400	72
Oilmeal	2	700	24	29	41,500	1,384	4	3,800	120
Cottonseed meal	1	600	19	13	19,900	679	1	200	7
Total purchased	......	458,300	$14,276	......	4,234,640	$131,969	......	265,800	$7,867
Total concentrates	......	463,200	$14,417	......	4,454,350	$138,051	......	285,300	$8,448

TABLE 41. SUCCULENT FEED USED BY 4136 COWS

Kind of feed	In pasture period: Number of herds using	In pasture period: Number of tons used	In pasture period: Value	In winter period: Number of herds using	In winter period: Number of tons used	In winter period: Value	When dry: Number of herds using	When dry: Number of tons used	When dry: Value
Home-grown:									
Corn silage	8	124	$ 868	92	4,612.1	$32,285	42	588	$4,116
Corn (green)	55	1,350.5	7,893	13	279.5	1,649	....	......	......
Sweet corn	2	43	159	....	......	......	....	......	......
Turnips and rutabagas	....	......	......	10	25	336	....	......	......
Potatoes	....	......	......	14	11.45	228	....	......	......
Mangels and beets	....	......	......	4	11.5	205	....	......	......
Millet	1	23	138	....	......	......	....	......	......
Oats	1	10	80	....	......	......	....	......	......
Oats and buckwheat	2	17	155	....	......	......	....	......	......
Alfalfa	6	37.5	400	....	......	......	....	......	......
Clover	6	96.75	605	1	7	70	....	......	......
Rowen	3	20.5	119	....	......	......	....	......	......
Total home-grown	....	1,722.25	$10,417	....	4,946.55	$34,773	....	588	$4,116
Skimmilk*	....	......	......	....	1.325	$6	....	......	......
Purchased:									
Corn silage	....	......	......	1	12	$90	....	......	......
Total purchased	....	......	......	....	12	$90	....	......	......
Total succulent feed	....	1,722.25	$10,417	....	4,959.875	$34,869	....	588	$4,116
Total succulent feed except skimmilk	....	1,722.25	$10,417	....	4,958.55	$34,863	....	588	$4,116

* Not included in table 4, page 10.

TABLE 42. DRY FORAGE USED BY 4136 COWS

Kind of feed	In pasture period: Number of herds using	In pasture period: Number of tons used	In pasture period: Value	In winter period: Number of herds using	In winter period: Number of tons used	In winter period: Value	When dry: Number of herds using	When dry: Number of tons used	When dry: Value
Home-grown:									
Mixed hay	....	......	......	152	5,429.1	$106,083	129	1,816.6	$35,394
Timothy hay	....	......	......	65	1,296.55	26,335	46	463	9,343
Clover hay	....	......	......	135	1,900.3	36,088	27	131.8	2,429
Clover hay, second cut	1	6	$90	4	28	645	....	......	......
Alfalfa hay	....	......	......	19	190.3	4,580	....	......	......
Alfalfa hay, second cut	....	......	......	1	4	92	....	......	......
Oat hay	....	......	......	16	116	1,959	4	12	214
Oat and pea hay	....	......	......	4	26	446	1	4	80
Wheat hay	....	......	......	1	2	34	....	......	......
Rye hay	....	......	......	1	5.1	61	....	......	......
Total hay	....	6	$90	....	8,997.35	$176,323	....	2,427.4	$47,460
Oat straw	....	......	......	102	417.025	$3,630	83	307.4	$2,692
Oat and barley straw	....	......	......	2	12	78	2	12	78
Wheat straw	....	......	......	3	7.1	98	....	......	......
Corn stover	....	......	......	62	694	6,050	9	35.5	395
Total home-grown	....	6	$90	....	10,127.475	$186,179	....	2,782.3	$50,625
Purchased:									
Mixed hay	....	......	......	40	281.75	$4,686	2	24	$262
Cornstalks	....	......	......	1	6	30	....	......	......
Total purchased	....	......	......	....	287.75	$4,716	....	24	$262
Total dry forage	....	6	$90	....	10,415.225	$190,895	....	2,806.3	$50,887

less than 25 per cent, 59 farms producing from 25 to 35 per cent, 56 farms producing from 35 to 45 per cent, and 28 farms producing over 45 per cent, of the year's milk in this period. The first group consisted of farmers following extreme summer dairying, and the last group of those following intensive winter dairying with cows freshening in the fall. For all farms an average of 46.2 per cent of the cows, or nearly half, freshened in March and April, and 16.7 per cent freshened from September to December inclusive. As most of the milk was produced for condenseries, the common practice is to have the cows freshen in the spring. The number of days the cows were dry were slightly less in winter dairies.

The number and proportion of cows freshening each month is shown in table 43:

TABLE 43. Cows Freshening Each Month, in the Four Seasonal Groups and in All Herds

	Per cent of milk sold wholesale, produced in six months November to April								All herds	
	Less than 25		From 25 to 35		From 35 to 45		More than 45			
	Cows freshening each month									
	Number	Per cent	Number	Per cent	Numb r	Per cent	Number	Per cent	Number	Per cent
January	13	3.2	114	8.1	189	13.4	100	15.8	416	10.8
February	54	13.4	244	17.2	209	14.9	87	13.8	594	15.4
March	121	30.0	410	29.0	299	21.2	90	14.3	920	23.8
April	170	42.1	384	27.1	242	17.2	70	11.1	866	22.4
May	24	5.9	97	6.9	69	4.9	45	7.1	235	6.1
June	9	2.2	52	3.7	38	2.7	20	3.2	119	3.1
July	....	....	14	1.0	22	1.6	5	0.8	41	1.1
August	....	....	9	0.6	9	0.6	4	0.6	22	0.6
September	....	....	5	0.3	21	1.5	14	2.2	40	1.0
October	3	0.7	15	1.1	39	2.8	35	5.6	92	2.4
November	3	0.8	20	1.4	110	7.8	67	10.6	200	5.2
December	7	1.7	51	3.6	161	11.4	94	14.9	313	8.1
Year	404	100.0	1,415	100.0	1,408	100.0	631	100.0	3,858	100.0

The cost of production, prices received, and returns per hour of labor, for the four groups are shown in table 44. The herd cost of production per 100 pounds was 45 cents less, the average price received per 100 pounds was 32 cents more, and the returns per hour of human labor, after all other costs were met, were 18 cents per hour more, for the intensive winter herds than for the most extensive dairies. One reason why the herds tending more toward winter dairying gave the highest returns per hour of time spent, was because the prices of milk for the winter months covered by the study were considerably higher relative to the prices in the summer months than they are normally.

Since the farmer is able to produce a large proportion of the family living on his own farm, low returns per hour do not force him out of business,

TABLE 44. RELATION OF SEASON OF PRODUCTION TO VARIOUS FACTORS

	Per cent of milk sold wholesale, produced in six months November to April			
	Less than 25	From 25 to 35	From 35 to 45	More than 45
Number of farms	20	59	56	28
Acres per farm	146	173	176	158
Average miles to milk station	3.4	3.0	2.6	2.3
Number of cows	436.5	1,539.5	1,489.0	670.5
Cows per farm	21.8	26.1	26.6	23.9
Cattle units	527.0	1,876.1	1,797.7	806.5
Cattle units per farm	26.4	31.8	32.1	28.8
Value of cows per head	$129.00	$141.00	$147.00	$143.00
Number of farmers using registered purebred bulls	2	14	15	11
Herd cost of milk per 100 pounds sold	$4.02	$3.96	$3.84	$3.57
Cow cost of milk per 100 pounds sold	$3.73	$3.70	$3.58	$3.38
Average price received for milk sold wholesale, per 100 pounds	$2.82	$2.91	$3.01	$3.14
Average price received for milk sold wholesale, stabling period, per 100 pounds	$3.33	$3.40	$3.47	$3.52
Average price received for milk sold wholesale, pasture period, per 100 pounds	$2.62	$2.64	$2.64	$2.65
Rates asked by farmers for human labor per hour	$0.31	$0.34	$0.36	$0.36
Rates received per hour of human labor	$0.10	$0.13	$0.19	$0.28

especially if his indebtedness is low, but they do force a restricted standard of living, and postponement in the upkeep of farm property. The fact that houses on many dairy farms are in need of improvements, and that barns on many dairy farms need repairing, is due not to a lack of desire on the part of the farmers to undertake these improvements but to the lack of money.

In order to make fair comparisons of the gain or loss between groups of farms, milk not paid for was treated as though the money had been received. Therefore, in all cases the value of milk not paid for is included in the returns.

The loss was $39.37 per cow in the extreme summer dairies, and it diminished as more of the milk was produced in winter. The least loss per cow was in the group of winter dairies, where it averaged $13.33 per cow.

The average price received for milk sold wholesale in Broome County was $1.45 per 100 pounds in the pasture season and $1.81 in the winter period. The winter price was thus 125 per cent of the summer price. In Herkimer County the average price of milk sold wholesale was $2.64 in the pasture period and $3.45 in the winter period. The winter price in Herkimer County was thus 131 per cent of the summer price. In Broome County the feed cost was 30 cents per 100 pounds of milk in the pasture period and $1.85 in winter. The winter feed cost was thus 617 per cent of the summer feed cost. In Herkimer County the feed cost was 60 cents per 100 pounds in the pasture period and $4.28 in winter. The winter feed cost was thus 717 per cent of the summer feed cost. Altho winter feed was higher in proportion to summer feed than winter milk was higher in proportion to

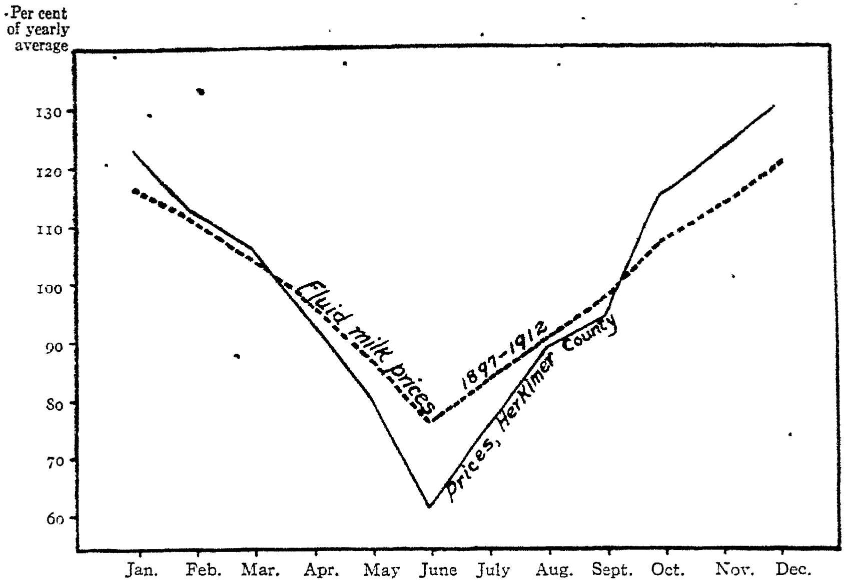

FIGURE 4. COMPARISON OF SPREAD IN MILK PRICES FOR THE YEAR AND AREA STUDIED, WITH THE NORMAL SEASONAL VARIATION IN FLUID-MILK PRICES

summer milk in Herkimer than in Broome County, the year-round dairyman in Herkimer County did better than the summer dairyman.

These results are contradictory to the findings in Broome County, where the least loss was with the summer system.

In table 45 the monthly production per cow of milk and of butterfat, and the monthly receipts from milk sold, are shown. In figure 5 a com-

TABLE 45. PRODUCTION PER COW AND ITS DISTRIBUTION, 4136 COWS

	Pounds of milk per cow	Pounds of butterfat per cow	Receipts per cow from milk sold
Milk sold:			
May	580	19.5	$14.78
June	687	22.9	13.08
July	588	20.1	14.04
August	505	18.3	14.54
September	407	15.5	12.86
October	316	12.4	12.23
November	190	7.7	7.85
December	208	8.0	9.01
January	216	8.0	8.82
February	269	9.5	9.93
March	403	13.6	13.56
April	507	16.8	14.81
Total	4,876	172.3	$145.51
Milk not sold	297	11.0	$9.10
Total	5,173	183.3	$154.61

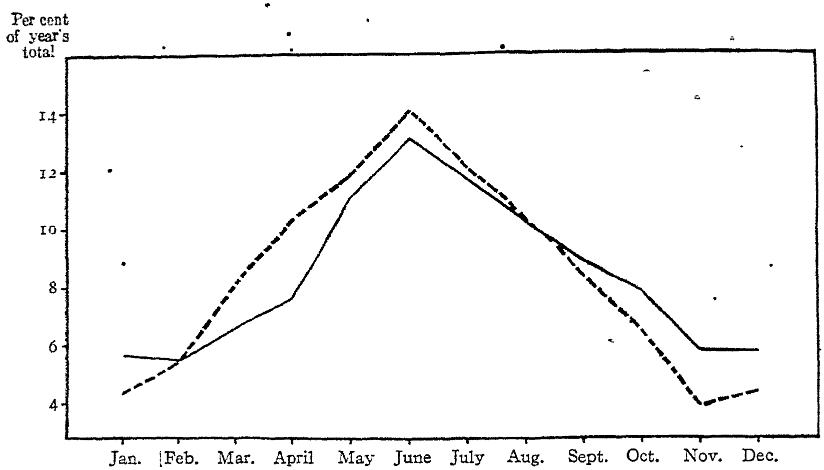

FIGURE 5. COMPARISON OF THE SEASONAL DISTRIBUTION OF MILK MANUFACTURED IN THE UNITED STATES, WITH THE SEASONAL DISTRIBUTION OF PRODUCTION ON 163 HERKIMER COUNTY FARMS

The solid line marks the production of milk used for manufactured dairy products in the United States in 1918; the broken line, the production on 163 farms in Herkimer County from May 1, 1918, to April 30, 1919

parison is made of the monthly distribution of the production of milk used in manufactured dairy products in the United States for the year 1918,[3] and the production on the 163 Herkimer County farms as shown in table 45. This comparison indicates that a relatively larger amount of milk was produced in March, April, and May in Herkimer County than for the United States as a whole. This would make it appear that the cows freshened earlier in the spring, dried off more rapidly in summer, and reached a lower point of production in winter. Since Herkimer County has long been a cheese-producing area, it would be expected to produce more milk in summer than the United States. The United States production includes much butter made in early fall and in the winter months, which is not characteristic of an exclusive cheese-producing area.

In tables 46, 47, and 48, respectively, the concentrates, succulent feed, and dry forage used by 4136 cows as divided in four seasonal groups, as previously indicated, are shown. The average price of feed per ton, for each group, is given at the foot of each table. The noticeable difference in the kinds of concentrates used is that the herds producing a larger proportion of milk in winter used relatively more high-protein concentrates, such as gluten feed, Larro Feed, and Union Grains. The herds producing a larger proportion of milk in winter used also a relatively larger proportion of mixed and clover hay, since they were situated on land better adapted to the production of leguminous forage.

[3] *The Market Reporter*, vol. 1, no. 14, pages 214–215. The milk equivalent is found by computing the amount of whole milk required for the products reported to be manufactured. The difficulties of obtaining data to indicate the monthly production in the United States, and the likelihood of slight error in the distribution, are readily appreciated.

TABLE 46. CONCENTRATES USED BY 4136 COWS IN FOUR SEASONAL GROUPS

Kind of feed	Per cent of milk sold wholesale, produced in six months November to April							
	Less than 25		From 25 to 35		From 35 to 45		More than 45	
	Amount (hundredweight)	Value	Amount (hundredweight)	Value	Amount (hundredweight)	Value	Amount (hundredweight)	Value
Home-grown:								
Oats	290	$767	341	$938	600	$1,797	168.6	$426
Corn	92.5	319	128	402	77	248	43	151
Barley	......	......	79	216	126	222	57	95
Oats and barley	......	......	28	88	170	425	......	......
Wheat bran	1	2	31	93	3	8	......	......
Oats and peas	......	......	......	......	10	25	......	......
Buckwheat	......	......	......	......	1	1	......	......
Total home-grown	383.5	$1,088	607	$1,737	987	$2,726	268.6	$672
Purchased:								
Ground oats	24	$ 66	905	$2,504	894	$ 2,294	5	$ 15
Cornmeal	125	422	288	912	385	1,309	80	263
Corn and oats	......	......	427	1,294	80	240	8	26
Barley feed	......	......	165	450	177	473	......	......
Hominy	24	68	......	......	185	608	9	28
Oats and barley	......	......	102	265	46	115	......	......
Wheat bran	117	311	373	955	859	2,127	191	476
Wheat feed	100	260	155	418	233	596	369	962
Wheat middlings	166	474	100	254	90	240	9	24
Cottonseed feed	......	......	......	......	......	......	30	75
H. O. molasses feed	93	260	286	796	128	390	30	98
Molasses	29	89	226	641	40	106	......	......
H. O. milk feed	......	......	174	471	26	73	......	......
H. O. stock feed	......	......	......	......	28	78	......	......
Purina Cow Chow	32	101	44	125	924.4	2,911	40	110
Mormilk	1	3	618	1,961	275	881	......	......
Internat. Ready Ration	......	......	......	......	653	1,779	......	......
Internat. Climax Feed	......	......	......	......	52	143	397	992
Faramel	......	......	......	......	38	125	......	......
International Stock Feed	17	52	......	......	65	203	......	......
Schumacher	232	676	329	941	818	2,352	57	165
Portage Stock	......	......	52	143	......	......	......	......
Arcady Stock	......	......	77	194	......	......	......	......
Grandin's Mixed Feed	......	......	33	84	......	......	......	......
Badger's	......	......	35	104	......	......	......	......
Buffalo Mixed	......	......	20	55	......	......	......	......
Lucky Strike	......	......	6	18	6	17	......	......
Dairy Feed	......	......	......	......	5	16	......	......
Kinds not found (low protein)	......	......	77	185	......	......	2	6
Larro Feed	431	1,461	2,901	9,224	5,647	18,047	3,219	9,791
Union Grains	449	1,509	2,396	8,019	3,229	11,156	2,396	8,077
Unicorn	207	691	126	420	229	743	209	687
Big Q	50	162	528	1,711	1,200	3,738	488	1,569
Stevens	......	......	765	2,565	932	3,087	438	1,455
Krause Dairy Feed	80	248	879	2,932	138	469	611	2,028
Syragold	40	130	567	1,685	706	2,109	65	196
Globe Creamery	56	174	519	1,723	313	1,014	268	869
Bufceco	......	......	223	739	180	516	27	83
Cream City Dairy	......	......	47	144	157	517	10	34
Boston Mixed	118	301	......	......	......	......	18	52
Amco Dairy	......	......	......	......	......	......	130	422
Monarch	......	......	......	......	38	103	50	143
Maroni	......	......	......	......	21	68	......	......
Jem Creamery	......	......	......	......	10	28	......	......
Twin Six	......	......	......	......	5	17	......	......
Kinds not found (higher protein)	......	......	......	......	383	1,150	......	......
Gluten feed	92	313	266	825	642	1,980	1,117	3,147
Oilmeal	12	41	119	375	235	814	56	178
Cottonseed meal	23	80	69	227	83	284	30	101
Total purchased	2,518	$7,898	13,897	$43,359	20,155.4	$62,916	10,359	$32,072
Total concentrates	2,901.5	$8,980	14,504	$45,096	21,142.4	$65,642	10,627.6	$32,744
Average price of concentrates per ton	$61.94		$62.18		$62.10		$61.62	

TABLE 47. SUCCULENT FEED USED BY 4136 COWS IN FOUR SEASONAL GROUPS

Kind of feed	Per cent of milk sold wholesale, produced in six months November to April							
	Less than 25		From 25 to 35		From 35 to 45		More than 45	
	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value
Home-grown:								
Corn silage	147	$1,029	1,013.8	$7,098	2,193.3	$15,351	1,382	$9,675
Corn (green)	209	1,182	940.5	5,616	381	2,225	99.5	519
Sweet corn	28	84	......	......	15	75	......	....
Turnips and rutabagas	0.1	1	11.7	163	6	82	7.2	90
Potatoes	1.05	14	4.1	63	2.2	34	4.1	117
Mangels and beets	......	......	8	160	3.5	45	......	....
Millet	......	......	......	......	23	138	......	....
Oats	10	80	......	......	......	......	......	....
Oats and buckwheat	......	......	......	......	......	......	15	105
Oats, peas, and buckwheat	......	......	......	......	2	50	......	....
Alfalfa	12	96	4.5	72	21	232	......	....
Clover	......	......	7	52	91.75	583	5	40
Rowen	1.5	18	12	80	7	21	......	....
Total home-grown	408.65	$2,504	2,001.6	$13,304	2,745.75	$18,836	1,512.8	$10,546
Skimmilk*	......	......	......	......	1.325	$6	......	....
Purchased:								
Corn silage	......	......	12	$90	......	......	......	....
Total purchased	......	......	12	$90	......	......	......	....
Total succulent feed	408.65	$2,504	2,013.6	$13,394	2,747.075	$18,842	1,512.8	$10,546
Total succulent feed except skimmilk	408.65	$2,504	2,013.6	$13,394	2,745.75	$18,836	1,512.8	$10,546
Average price of succulent feed per ton	$6.13		$6.65		$6.86		$6.97	

* Not included in table 4, page 10.

A larger proportion of the farms producing much winter milk than of the spring dairies grew silage, and the feeding of silage and concentrates was heavier per cow in such herds. Silage is an expensive feed, and too costly to feed to spring-fresh cows in regions of cheap land where plenty of pasture and hay can be obtained at a reasonable land cost. Improved roads, motor transportation, and cooperative associations have stimulated the production of milk in the less favorable localities. This, with high wages, makes the advantage of a silo less than it was formerly, and on many farms there are unused or partly filled silos.

TABLE 48. DRY FORAGE USED BY 4136 COWS IN FOUR SEASONAL GROUPS

Kind of feed	Per cent of milk sold wholesale, produced in six months November to April							
	Less than 25		From 25 to 35		From 35 to 45		More than 45	
	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value
Home-grown:								
Mixed hay	580.5	$10,705	2,261	$44,099	1,919	$38,696	668.6	$12,583
Timothy hay	317.5	6,408	536.5	11,087	315.75	6,340	126.8	2,500
Clover hay	186	3,293	634	12,250	728	14,107	352.3	6,438
Clover hay (second cut)	....	......	....	......	22	540	12	195
Alfalfa hay	20	420	35	940	58	1,296	77.3	1,924
Alfalfa hay (second cut)	....	......	4	92	....	......	....	....
Oat hay	6	98	52	836	41	760	17	265
Oat and pea hay	5	50	20	376	....	......	1	20
Wheat hay	2	34	...	......	....	......	....	....
Rye hay	....	......	....	......	....	......	5.1	61
Total hay	1,117	$21,008	3,542.5	$69,680	3,083.75	$61,739	1,260.1	$23,986
Oat straw	60.5	$ 425	183.175	$1,580	137.45	$1,338	35.9	$287
Oat and barley straw	....	......	12	78	....	......	....	....
Wheat straw	1.5	4	....	......	1.5	12	4.1	82
Corn stover	135.25	1,277	389.65	3,475	107.7	764	61.4	534
Total home-grown	1,314.25	$22,714	4,127.325	$74,813	3,330.4	$63,853	1,361.5	$24,889
Purchased:								
Mixed hay	38	$540	98.3	$1,545	101.7	$1,843	43.75	$758
Corn stover	....	......	6	30	....	......	....	....
Total purchased	38	$540	104.3	$1,575	101.7	$1,843	43.75	$758
Total dry forage	1,352.25	$23,254	4,231.625	$76,388	3,432.1	$65,696	1,405.25	$25,647
Average price of dry forage per ton	$17.20		$18.05		$19.14		$18.25	

In table 49 are shown the quantities of grain, silage, and other roughage used per 100 pounds of milk produced in the pasture and winter periods, and also the amounts used per cow per day by the cows when dry. The average quantities of feed used per cow per day when dry were as follows: grain, 1.2 pounds; silage, 5 pounds; hay and other dry forage, 24 pounds. The amount of energy in the feed used by cows when dry is equivalent to the amount of energy contained in about 30 pounds of hay.

The larger proportion of clover and mixed hay on the farms producing more of the milk in winter is an indication that they were situated on land better adapted to growing leguminous roughage, and probably also that better methods were used. Winter dairying is a system for the man who will put pressure into his farming operations. It often goes with good cows, better farming, and adeptness on the part of the operator to adjust his system to changing conditions.

TABLE 49. FEED USED BY COWS

Per cent of milk sold wholesale, produced in six months November to April	Kind of feed	Pounds used in pasture period: Per 100 pounds of milk produced	Pounds used in pasture period: Per pound of butterfat produced	Pounds used in winter period: Per cow per day	Pounds used in winter period: Per 100 pounds of milk produced	Pounds used in winter period: Per pound of butterfat produced	Pounds used by dry cows: Per cow per day dry	Pounds used in winter, excluding feed for dry cows: Per 100 pounds of milk produced	Pounds used in winter, excluding feed for dry cows: Per pound of butterfat produced
Less than 25	Grain	0.4	0.1	3.3	47.9	13.0	0.5	45.9	12.4
	Silage	....	....	3.4	49.4	13.4	1.4	43.1	11.7
	Other succulent feed	36.4	10.4	0.03	0.4	0.1	....	0.4	0.1
	Hay	....	....	27.0	388.5	105.5	24.2	278.8	75.7
	Other dry forage	....	....	4.6	66.3	18.0	3.9	48.5	13.2
From 25 to 35	Grain	2.2	0.6	4.5	50.5	14.2	0.9	47.0	13.2
	Silage	2.8	0.8	6.4	72.0	20.2	3.7	58.5	16.4
	Other succulent feed	34.4	9.7	1.3	14.7	4.1	....	14.7	4.1
	Hay	....	....	24.1	272.7	76.5	21.6	192.9	54.1
	Other dry forage	....	....	3.9	44.2	12.4	3.5	31.3	8.8
From 35 to 45	Grain	6.2	1.7	6.3	49.5	14.0	1.8	45.7	13.0
	Silage	2.5	0.7	14.7	115.1	32.6	5.4	104.0	29.5
	Other succulent feed	19.1	5.4	0.9	6.7	1.9	....	6.7	1.9
	Hay	....	....	21.8	171.5	48.6	19.5	131.1	37.1
	Other dry forage	....	....	1.7	13.3	3.8	2.8	7.4	2.1
More than 45	Grain	4.7	1.3	7.5	44.8	12.9	1.3	43.0	12.3
	Silage	0.5	0.1	21.0	125.8	36.1	11.9	109.2	31.3
	Other succulent feed	13.7	3.9	0.2	1.2	0.3	....	1.2	0.3
	Hay	0.7	0.2	19.7	118.5	34.0	20.1	90.3	25.9
	Other dry forage	....	....	1.5	9.3	2.7	1.3	7.4	2.1
All herds	Grain	3.8	1.1	5.5	48.6	13.7	1.2	45.5	12.8
	Silage	2.0	0.6	11.4	100.9	28.5	5.0	88.0	24.9
	Other succulent feed	26.1	7.4	0.8	7.3	2.1	....	7.3	2.1
	Hay	0.1	0.03	22.9	202.4	57.2	21.0	148.9	42.1
	Other dry forage	....	....	2.8	24.8	7.0	3.0	17.0	4.8

COST OF RAISING HEIFERS

The expense of raising cattle during the period of inflation has been much in excess of that in pre-war years. Those who raised heifers on the high-priced feed, milk, and labor of the war years will sell milk from them for a much lower price than that which prevailed during the war. On the farms included in this study, the average cost of raising a heifer till freshening was $133.18. The cost was higher in winter dairies than in summer dairies. The average age at the time of first freshening was thirty months.

Of the 450 heifers freshening for the first time, 26 per cent were twenty-four months old or less, 18 per cent were from twenty-five to thirty months old, and 55 per cent were thirty months of age or older (table 50).

TABLE 50. DISTRIBUTION OF HEIFERS FRESHENING, BY THEIR AGE AT THE TIME OF FIRST CALVING

Age at time of first freshening (months)	Number of heifers	Per cent of total
17	1	0.2
18	1	0.2
20	3	0.7
21	1	0.2
23	4	0.9
24	109	24.2
25	23	5.1
26	30	6.7
27	15	3.3
28	9	2.0
29	6	1.3
30	51	11.3
32	6	1.3
33	5	1.1
34	20	4.5
35	16	3.6
36	124	27.6
37	18	4.0
38	7	1.6
48	1	0.2
Total	450	100.0

There are no reliable statistics to indicate whether relatively more or less heifers were raised during the war years than before. Enough heifers to maintain the herds are always raised. The raising of dairy cows is not subject to such extreme over- and under-production as are the potato and cabbage crops, with which both weather and adjustments in acreage are so influential. It is probable, however, that the high prices for milk, veal, and grain resulted in fewer heifers being raised. If the dairies producing city milk raised fewer heifers during the war period, it was to their economic advantage, because in 1921 they could buy the two- or three-year-olds for less than the cost of raising.

In times of rising prices for feed, labor, equipment, and other materials, and for milk, farmers soon adjust the prices of cows accordingly, but the

adjustment of young cattle values to these new and higher price levels is slower. In this region the herd cost of milk was 25 cents per hundred pounds more than the cow cost. In Broome County in 1915, before the currency inflation occurred, the difference between costs computed in the two ways was only 1 cent per hundred pounds. The reason for the large difference in the Herkimer region was the large loss on heifers. The appreciation on heifers allowed by the farmers was no greater than under pre-war conditions, but the costs were probably nearly double. The details of costs and returns for heifers in the four seasonal groups and in all herds are given in table 51. The amounts and value of the concentrates, succulent feed, and dry forage used by heifers, are shown in tables 52, 53, and 54, respectively.

Not only the cost of raising a dairy heifer from birth to the time of first freshening must be considered, but on well-organized farms the concentrates, silage, dry roughage, pasture, use of buildings, and labor involved in raising cattle, can often be utilized more profitably in the production of milk. When an exceptional price is paid, as for certified, retailed, or Grade A milk, often the most profitable practice is to keep grade stock and buy cows to maintain the herd.

Sometimes the price of the product may be high enough to justify pasturing high-priced tillable land by the cattle producing it. Seldom, however, can one afford to raise cattle on this high-priced land unless the cattle have a proportionately high value when raised. This is rarely the case with grades. It usually happens that cows of equally good quality raised under cheaper conditions may be purchased at less than the cost to raise them under expensive conditions.

A small proportion of the cattle raised are usually discarded because of poor quality. The risk at calving time is greatest with first-calf heifers. Two- and three-year-old heifers do not milk so heavily as older cows. The dairyman who raises cows to maintain his dairy must accept all the losses that come in these ways, not only the direct losses, but also the losses of opportunities for profit which accompany the direct losses. Dairymen who replace their herds entirely by purchase can buy animals of whatever health and production capacities their own judgment guides them to select. The seller knows his animals, and his chances of making a good sale are fully as great as those of the buyer to make a wise choice.

TABLE 51. Summary of Costs and Returns for 1410 Heifers

	Per cent of milk sold wholesale, produced in six months November to April								All herds	
	Less than 25		From 25 to 35		From 35 to 45		More than 45			
	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value
Costs:										
Grain	24,250 pounds	$ 676	105,650 pounds	$ 3,220	170,850 pounds	$ 5,052	64,950 pounds	$1,917	365,700 pounds	$10,865
Succulent feeds (except skimmilk)	21.1 tons	151	141.4 tons	998	190.6 tons	1,345	106.5 tons	749	459.6 tons	3,243
Dry forage	202 tons	3,761	777.5 tons	14,642	671.55 tons	13,236	288.2 tons	5,450	1,939.25 tons	37,089
Skimmilk, purchased	1.4 tons	9	1.2 tons	8	....	......	1.1 tons	11	3.7 tons	28
Skimmilk, farm	15,210 pounds	24	21,010 pounds	92	7,255 pounds	28	3,063 pounds	15	46,538 pounds	159
Whole milk, farm	56,170 pounds	1,772	168,284 pounds	5,601	169,068 pounds	5,783	49,839 pounds	1,692	443,361 pounds	14,848
Pasture	....	741	....	2,451	....	2,296	....	953	....	6,441
Bedding	....	83	....	419	....	430	....	166	....	1,098
Human labor	4,645 hours	1,605	15,777 hours	6,396	14,789 hours	6,387	5,934 hours	2,493	41,145 hours	16,881
Horse labor	84 hours	17	669 hours	136	729 hours	139	186 hours	38	1,668 hours	330
Use of buildings	....	283	....	1,283	....	1,235	....	620	....	3,421
Use of equipment	....	66	....	296	....	312	....	176	....	850
Interest on cattle	....	289	....	1,285	....	1,166	....	552	....	3,292
Interest on feed and supplies	....	95	....	356	....	385	....	189	....	1,025
Miscellaneous	....	17	....	127	....	159	....	75	....	378
Total costs	....	$9,589	....	$37,310	....	$37,953	....	$15,096	....	$99,948
Returns:										
Appreciation	....	$4,669	....	$21,328	....	$20,827	....	$9,224	....	$56,048
Manure	469 tons	1,222	2,008.6 tons	5,223	1,864.3 tons	4,846	831.7 tons	2,164	5,173.6 tons	13,455
Total returns	....	$5,891	....	$26,551	....	$25,673	....	$11,388	....	$69,503
Loss	....	$3,698	....	$10,759	....	$12,280	....	$3,708	....	$30,445
Value at birth, plus purchases, less sales and hides	....	$119	....	$3,071	....	$2,722	....	$1,235	....	$7,147
Total cost of raising heifers till two years old	....	$8,486	....	$35,158	....	$35,829	....	$14,167	....	$93,640
Number of cattle units	69.5	......	277.4	......	244.3	......	111.9	......	703.1	......
Cost, per cattle unit, of raising heifers till two years old*	....	$122.10	....	$126.74	....	$146.66	....	$126.60	....	$133.18
Value at time of first freshening	42	$4,340	197	$20,880	149	$17,360	62	$7,520	450	$50,100
Value per heifer at time of first freshening	....	$103.33	....	$105.99	....	$116.51	....	$121.29	....	$111.33

* In this work, this figure is considered to be the cost of raising a heifer till two years old. Since the average age at the time of first freshening was thirty months, the cost to this age would be possibly 25 per cent higher.

TABLE 52. CONCENTRATES USED BY 1410 HEIFERS IN FOUR SEASONAL GROUPS

Kind of feed	Per cent of milk sold wholesale, produced in six months November to April							
	Less than 25		From 25 to 35		From 35 to 45		More than 45	
	Amount (hundred-weight)	Value	Amount (hundred-weight)	Value	Amount (hundred-weight)	Value	Amount (hundred-weight)	Value
Home-grown:								
Oats	61	$141	103	$285	206	$573	65	$170
Corn	1	3	13	51	......	......	4	10
Barley	......	......	......	......	4	12	45	79
Oats and barley	......	......	3	9	41	102	......	......
Total home-grown	62	$144	119	$345	251	$687	114	$259
Purchased:								
Ground oats	8	$ 19	139	$384	149	$ 394	15	$ 38
Cornmeal	16	53	30	100	44	155	15	51
Corn and oats	......	......	65	205	......	......	44	143
Barley feed	......	......	9	25	6	17	15	38
Hominy	1	3	6	21	5	18	......	......
Oats and barley	......	......	......	......	12	30	......	......
Oatmeal	......	......	2	10	......	......	1	10
Wheat bran	39	103	60	154	184	441	32	74
Wheat feed	19	54	2	4	45	127	23	64
Wheat middlings	10	29	6	13	26	67	1	4
H. O. molasses feed	9	25	......	......	2	6	......	......
Molasses	2	6	2	6	......	......	......	......
H. O. milk feed	......	......	13	35	10	28	......	......
Purina Cow Chow	6	19	......	......	20	60	......	......
Mormilk	......	......	23	74	......	......	......	......
Internat. Ready Ration	......	......	......	......	60	164	......	......
Internat. Climax Feed	......	......	......	......	......	......	21	53
Faramel	......	......	......	......	2	7	60	198
Schumacher	14	40	70	201	207	596	37	110
Portage Stock	......	......	40	110	......	......	......	......
Grandin's Mixed Feed	......	......	25	64	......	......	......	......
Kinds not found (low protein)	......	....	3	7	......	......	......	......
Larro Feed	7	23	119	385	421	1,344	78	260
Union Grains	16	53	85	272	118	409	49	163
Unicorn	......	......	6	21	1	3	4	13
Big Q	......	......	4	13	2	6	22	72
Stevens	......	......	45	152	25	83	1	3
Krause Dairy Feed	......	......	......	......	10	32	......	......
Syragold	......	......	42	126	40	120	......	......
Globe Creamery	......	......	62	201	5	15	......	......
Bufceco	......	......	10	30	......	......	41	113
Cream City Dairy	......	......	3	9	3	10	......	......
Boston Mixed	18	46	......	......	......	......	......	......
Monarch	......	......	......	......	2	5	10	28
Blatchford's	......	......	26.5	129	10	48	7	42
Purina	......	......	......	......	2	12	17	61
Ryde's	......	......	1	6	3	18	......	......
Kroker's	1.5	5	......	......	......	......	......	......
Sucrene	0.5	3	......	......	......	......	......	......
Calf Chow	......	......	......	......	......	......	0.5	3
Krause	......	......	......	......	0.5	4	......	......
Kinds not found (higher protein)	1.5	8	......	......	1	8	......	......
Gluten feed	4	14	8	24	22	68	34	93
Oilmeal	6	22	31	94	15	52	8	24
Cottonseed meal	2	7	......	......	5	18	......	......
Total purchased	180.5	$532	937.5	$2,875	1,457.5	$4,365	535.5	$1,658
Total concentrates	242.5	$676	1,056.5	$3,220	1,708.5	$5,052	649.5	$1,917

TABLE 53. SUCCULENT FEED USED BY 1410 HEIFERS IN FOUR SEASONAL GROUPS

Kind of feed	Per cent of milk sold wholesale, produced in six months November to April							
	Less than 25		From 25 to 35		From 35 to 45		More than 45	
	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value
Home-grown:								
Corn silage	18.5	$129	126.1	$882	188.6	$1,321	102.5	$718
Corn (green)	2	10	14	92	......	......	3	9
Turnips and rutabagas	0.6	12	0.6	12	2	24	1	22
Potatoes	......	......	0.15	4	......	......	......	......
Alfalfa	......	......	0.5	8	......	......	......	......
Total home-grown	21.1	$151	141.35	$998	190.6	$1,345	106.5	$749
Purchased:								
Skimmilk	1.4	$9	1.2	$8	....	....	1.1	$11
Total purchased	1.4	$9	1.2	$8	......	......	1.1	$11
Total succulent feed	22.5	$160	142.55	$1,006	190.6	$1,345	107.6	$760
Total succulent feed except skimmilk	21.1	$151	141.35	$998	190.6	$1,345	106.5	$749

TABLE 54. DRY FORAGE USED BY 1410 HEIFERS IN FOUR SEASONAL GROUPS

Kind of feed	Per cent of milk sold wholesale, produced in six months November to April							
	Less than 25		From 25 to 35		From 35 to 45		More than 45	
	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value
Home-grown:								
Mixed hay	118	$2,272	577	$11,388	449	$9,241	230.9	$4,446
Timothy hay	68	1,293	99.5	2,039	155.25	3,009	17.7	369
Clover hay	......	......	31	623	34.5	651	18.2	308
Clover hay (second cut)	......	......	......	......	......	......	1.5	30
Alfalfa hay	......	......	2	44	......	......	5.7	147
Oat hay	......	......	......	......	3	60	2	30
Oat and pea hay	......	......	1	20	......	......	......	......
Rye hay	......	......	......	......	......	......	0.9	11
Total hay	186	$3,565	710.5	$14,114	641.75	$12,961	276.9	$5,341
Oat straw	7	$64	35.5	$287	28.8	$271	6.8	$61
Oat and barley straw	......	......	14	87	....	......	......	......
Wheat straw	......	......	......	......	......	......	0.9	18
Corn stover	5	55	17.5	154	1	4	3.6	30
Total home-grown	198	$3,684	777.5	$14,642	671.55	$13,236	288.2	$5,450
Purchased:								
Mixed hay	4	$77	......	......	......	......	......	......
Total purchased	4	$77	......	......	......	......	......	......
Total dry forage	202	$3,761	777.5	$14,642	671.55	$13,236	288.2	$5,450

October, 1924 Bulletin 433

Economic Studies of Dairy Farming in New York. II

Grade A Milk with and without Cash Crops

E. G. Misner

In cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture

GRADE A MILK FARM NEAR OXFORD, CHENANGO COUNTY

Published by the
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CONTENTS

ECONOMIC STUDIES OF DAIRY FARMING IN NEW YORK. II. GRADE A MILK WITH AND WITHOUT CASH CROPS

E. G. MISNER [1]

In a preceding publication,[2] the organization and management of dairy farms producing milk for a condensery was considered. This bulletin reports the financial results for the year ending April 30, 1922, for farms producing Grade A milk.

The survey method was used for this study. Complete cost accounts with all enterprises of the farm may furnish more reliable information for a particular farm; but the expense prevents obtaining information by this method from enough farms to allow study of the relation of variation in some of the important practices and features of the organization to the net returns in farming.

Research similar to that reported here may be done in other regions. Copies of the field sheets used may therefore be of service to other investigators and so are included here. Copies of office forms were included in the preceding publication already referred to.

In planning this investigation and the series of publications reporting it, the writer had in mind assembling and reporting data in considerable

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[1] The writer was assisted in the field by I. J. Call, M. Ezekiel, W. C. Funk, J. F. Harriott, E. R. Hoskins, W. G. Meal, C. H. Merchant, Bruce McKinley, and J. J. Vernon; and in the preparation of the blanks used by W. C. Funk. The information was gathered thru a cooperative agreement between the Department of Agricultural Economics and Farm Management of the New York State College of Agriculture at Cornell University, Ithaca, New York, and the Divisions of Farm Management and Cost of Production, Bureau of Agricultural Economics, United States Department of Agriculture, Washington, D. C.

The following farmers cooperated by furnishing information:

Operators, Oxford farms: Wm. Ashcraft, C. M. Balcom, J. E. Barber, Henry Barrows, Charles Beckwith, H. M. Bowers, W. S. Bowers, B. J. Brown, Jesse Burgess, L. J. Cady, Mrs. Elsie Caulkins, H. L. Clark, J. F. Cohoon, E. G. Cook, W. E. Cronk, John Cunningham, H. G. Davis, M. W. Davis, George C. Day, Glenn Denning, H. Dingman, L. I. Dodge, F. R. Fitch, George Foulds, D. W. Gould, J. E. Greenleaf J. J. Griffin, Floyd Hamilton, A. R. Harp, Milton Harrington R. A. Harris, C. L. Hill, Fred Hogan, George Hogan, C. B. Holmes, George Hopkins, Frank Hovey, L. Howland, C. H. Hunter, E. L. Ingraham, I. W. Ingraham, L. L. Lidell, G. H. Lloyd, Lowe Bros., John McEneny, J. H. McGowan, Edward Malloy, George Miles, Dell Miller, M. J. Money, C. L. Moore, L. R. Morehead, M. F. Mudge, Homer Padgett, Ward Padgett, Ray W. Parker, George Perkins, Jason Peterson, R. W. Quinn, Harry Roach, Bert Root, G. S. Root, Wm. Rose, J. M. Rounds, G. W. Scarlett, John Schlafer, L. H. Sharp, Carrol Sharpe, Mrs. H. E. Shepler, Arthur Smith, Leland Smith, C. H. Southard, A. W. Steere, E. L. Stratton, J. L. Thompson, Eugene Towslee, Bert Tucker, Edward Wackford, Floyd Wackford, H. C. Westover, Mrs. B. K. Wilcox, F. L. Wilcox, R. G. Wilcox, Mrs. M. J. Wright.

Landlords: Vincent Burgess, O. B. Cook, George H. Day, Larry Galhager, Alvin Hill, Mrs. M. E. Hitchcock, J. Hoban, W. G. Lenderson, J. J. Lillis, Ward Miller, Paisley and Race, Emma Rogers, Harriet Stafford, W. S. Stillwell, E. R. Storer, H. Stratton, M. B. Stratton, Albert Webb.

Operators, Tully and Homer farms: R. G. Ames, W. I. Ashmore, James Aungier, Wm. Backer, B. S. Baldwin, C. J. Bardwell, Fred Bartlett, F. E. Beck, Wm. Bell, W. H. and R. G. Blair, George Blum, Michael Brennen, Franklin Briggs, Frank Brown, R. A. Butler, Clark Button, Ira Button, Caughey Bros., Howard Coon, Fred Crampton, Daniels and Co., A. Deveraus, A. P. Edinger, B. J. Edinger, A. Esty, C. E. Fellows, Wright Gamble, E. C. Gilbert, Wm. Hamilton, J. H. Houch, Paul Houch, Homer Jones, Harry Kingsley, W. S. Kingsley, L. Long, H. F. Nelson, Walter Newman, Edward O'Connor, H. G. Ousby, G. L. Perry, John Reinman and son, Harry Reynolds, Charles Ripley, John Ryan, Paul Simons, Con. J. Sweeney, Jerry Sweeney, Tim Sweeney, F. W. Warner.

Landlords: H. W. Babcock, S. T. Banner and sons, Walter Briggs, Wm. Brown, Frank Carpenter, C. J. Cummings, J. Cummings, C. Kenyon, H. G. Padget, E. G. Ranney, W. B. Stoppard, Mrs. R. Van Patent, C. W. Wilkins.

The writer wishes to express his appreciation of the cooperation of the milk-buying concerns in furnishing certain information and photographs in this bulletin, and to acknowledge especially the cooperation of L. G. Colvin, superintendent of the Borden plant at Oxford, W. H. Marcussen, assistant manager of production for the Borden's Farm Products Company, and Dr. Charles E. North, of New York City. The copy for figures 1 5, 6, and 14 was furnished by the Clover Farms, Inc ; for figures 3, 4, 9, and 13 by the Borden's Farm Products Co.; for figures 7 and 8 by the Sheffield Farms Company.

[2] Economic studies of dairy farming in New York. I. Condensery milk without cash crops. By E. G. Misner. Cornell Univ. Agr. Exp. Sta. Bul. 421: 1–75. 1923.

detail for the various systems of dairy farming followed in New York. Altho the bulletins are primarily technical, they will be of more real value in such form to farmers than if they were confined to popular discussions without data.

HISTORY OF GRADE A MILK

In 1908 the New York Milk Committee operated seven milk depots, for feeding tenement babies certified milk obtained from the Tully Farms through a special arrangement with the Sheffield Farms Slawson Decker Company. The committee, feeling the necessity of obtaining clean milk at a lower cost, began purchasing it from dairy farms of a more ordinary type, making a careful inspection for sanitation and bacteria. The premium paid for this milk was about one cent per quart above the regular market price.

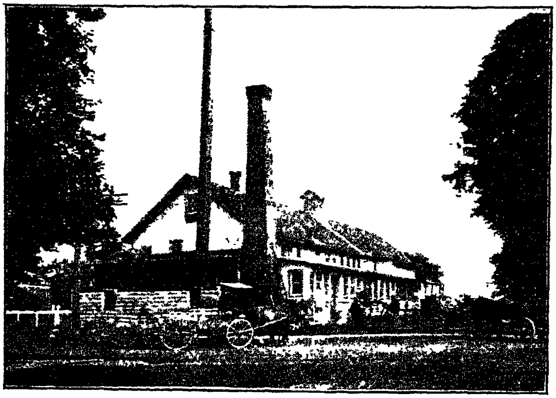

FIGURE 1. THE FIRST GRADE A MILK STATION IN THE UNITED STATES, AT HOMER, NEW YORK

More rigid control was considered necessary, however, so in 1910 a small milk company, The New York Dairy Demonstration Company, was organized by the New York Milk Committee for this purpose. W. C. Phillips, secretary of the committee, raised $25,000 in capital from a large number of subscribers to finance this undertaking. The officers were: Stephen Francisco, producer of the first certified milk, president; D. S. Horton, of the Sheffield Farms Co., vice president; Dr. Charles E. North, secretary; and M. L. Warren, treasurer. In the fall of 1910 Harry B. Winters succeeded C. H. Yates as business manager and served for one year; during that year five infant-feeding stations were using milk produced in the vicinity of Homer, New York. In 1911 a plant was established in Homer, equipped with a laboratory for making bacterial tests. In the next year, 1912, the business was enlarged. That year fifty-five infant-feeding stations in New York City were using Homer milk. In 1913 the business was purchased by the Clover Farms, Inc., which for the past ten years has had the exclusive trade of the health stations. Dr. North still supervises the bacterial testing and general sanitation of the business.

In 1911 the baby-health stations of New York City were taken over by the City Department of Health. Since then, the number of stations in operation has increased from 15 in that year to 70 in 1923.

In March, 1911, the New York Milk Committee invited twenty experts to become members of a commission on milk standards.[3] The outcome

[3]Commission on Milk Standards. Reprint 634, United States Treasury Department.

of five meetings of this commission during a period of over two years was the grading system, providing for Grade A, Grade B, and Grade C milk. For further information concerning these meetings, the reader is referred to the publication cited. It was milk of the Homer class which led to the development of the grading system and its adoption by the New York City Department of Health in 1912.

In the beginning four premiums were paid the dairyman, one for tuberculin test, one for sanitation, one for low bacteria count, and one for butterfat test. What is claimed to be one of the first statements for a full month sent out by the New York Dairy Demonstration Company is reproduced below (figure 2). The amounts of the premiums were as

STATEMENT

No. Month of June 1911

New York Dairy Demonstration Co.

In Account With Mr. Homer H. Jones

14534	Quarts of Milk = 363 14/40 Cans at $ 0.80	$290	68
	Quarts of Milk = Cans at $		
	Premium for Tuberculin Test @ 20¢	72	67
	Premium for Sanitation @ 10¢	36	34
	Premium for Low Bacteria Count @ 10¢	36	34
	Premium for Butter Fat @ 4¢	14	53
Penalties			
	Total	$450	56
	Received Payment,		

FIGURE 2. STATEMENT OF ONE OF THE EARLIEST PRODUCERS OF GRADE A MILK, SHOWING BASES ON WHICH PREMIUMS WERE PAID AT THAT TIME

indicated in the statement. After the farmers' costly experience, and with the coming of pasteurization into general use, the tuberculin-test requirement was abandoned, and now the reward for cleanliness is represented by one premium for low bacteria count.

For the past eighteen or twenty years the farms supplying the Borden plants at Oxford and Brisben have been under rigid periodic inspection by the company representatives and by the representatives of the health department of New York City, Newark, New Jersey, and Montclair, New Jersey. Until 1912 this milk was sold as Borden's milk without reference to any particular grade. Then upon recognition by the New York City Department of Health of Grade A and Grade B milk, both grades were put out at each of these plants, and, altho they were handled

within the same building, separate receiving, pasteurizing, and bottling equipment was used for each grade.

According to the 1912 regulations, the eligibility of milk from the different farms for either grade was determined by a score card from the New York City Department of Health, giving 40 points to equipment and 60 points to methods. To be eligible for Grade A, the farm was required to have a total score of 68 points, of which at least 25 must be for equipment and 43 for methods. In order to encourage the maintaining of conditions on farms that would result in this score, the company paid a premium of 15 cents per hundred pounds for all dairies making the 68 score.

While the health code of 1912 recognized bacterial standards, the prevailing idea at the time was that the quality of the milk was directly related to the premises, and no attempt was made to determine the count of bacteria in the milk as it came from the farm. The chief defect of this method was the inability of inspectors to score properly those methods that had the greatest influence on the quality of the milk.

In 1916 the New York City Department of Health revised its code, giving special emphasis to rigid bacterial standards, eliminating the numerical score card, and substituting a card with "yes" or "no" answers to questions concerning dairy premises. The new code also prohibited the purchaser from handling two grades of milk in the same building.

Oxford and Brisben were the first Borden stations at which a new plan for the purchase of Grade A milk on a bacterial basis was introduced by the Borden's Farm Products Company. In July, 1916, this company submitted to the producers a plan of paying 20 cents per 100 pounds for milk showing an average count of less than 10,000 colonies of bacteria per cubic centimeter of milk, or 10 cents for milk showing an average count between 10,000 and 25,000 colonies per cubic centimeter of milk, it being understood that dairy conditions satisfactory to the Department of Health must be maintained. Not being certain of the outcome of this plan, the producers were inclined to favor the barn-score premium as in the past. An agreement was finally reached whereby 15 cents would be paid for satisfactory barn conditions and 5 cents additional premium for low bacteria count, provided that the milk did not exceed a count of 25,000 per cubic centimeter. This plan continued in effect during August September, and October. From November 1, 1916, to January 1, 1921, the 20-cent or 10-cent premiums were paid. For the year 1921, premiums based on the same standards as those already mentioned were paid as follows: January to June inclusive, 25 cents or 15 cents; and July to December inclusive, 40 cents or 25 cents. For 1922 the premiums were 40 cents or 25 cents for all months except April, May, and June, when they were 25 cents or 15 cents.

The primary differences in the requirements for the production of Grade A and Grade B milk are shown in table 1. For Grade A milk the regulations state that it shall contain not more than 30,000 bacteria (colonies) per cubic centimeter when delivered to the consumer, or at any time after pasteurization; and not more than 100,000 at any time before pasteurization if pasteurized outside of New York City. If pas-

teurized within New York City, it shall contain not more than 200,000 bacteria (colonies) per cubic centimeter before pasteurization. For Grade B milk, the bacterial standards are respectively 100,000, 300,000 and 1,500,000, colonies under the above-named conditions.

TABLE 1. PRINCIPAL DIFFERENCES IN THE REQUIREMENTS FOR GRADE A AND GRADE B MILK

	Grade A	Grade B
New York City requirements:		
Time of delivery to receiving station	Before 8 a. m.	Before 9 a. m.
Temperature at time of delivery to receiving station	Not more than 50° F.	Not more than 60° F.
Bacterial standard (colonies per cubic centimeter) before pasteurization:		
When pasteurized in New York City	Not more than 200,000	Not more than 1,500,000
When pasteurized outside of New York City	Not more than 100,000	Not more than 300,000
When delivered to consumer	Not more than 30,000	Not more than 100,000
General inspection	Very strict	Strict
Buying-company requirements:		
Bacteria allowed for		
Full premium	Not more than 10,000	No premium paid
Part premium	From 10,000 to 25,000	
No premium	Over 25,000	

The desire of city consumers to be fully assured of clean, wholesome milk has led to an increased demand for Grade A milk. The basis of quality of this grade of milk rests first with the dairyman, who in most cases fully appreciates the responsibility. In addition to passing the monthly inspection of the milk company's representatives, and the New

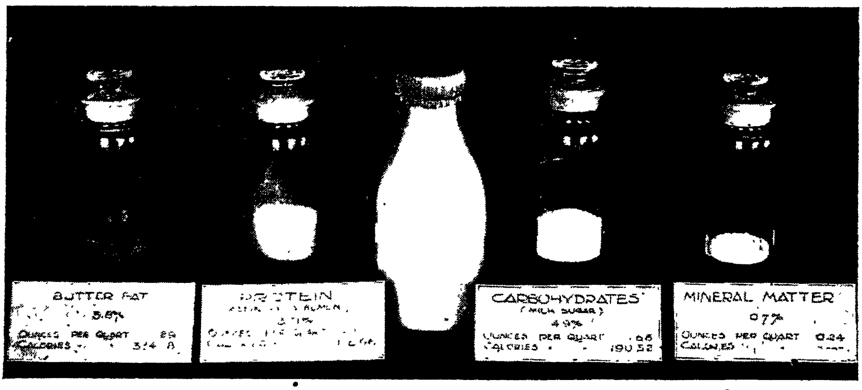

FIGURE 3. FOOD VALUE OF MILK

In addition to the solids pictured here, milk is relatively rich in vitamines, which are necessary for health and growth and are lacking in many other foods

York City Department of Health inspection according to the standard score card now used, all night's milk must be cooled on the farm immediately after milking and maintained at a temperature below 50° F. The morning's milk need not be cooled if received at the factory before 8 a. m.; otherwise that also must reach the factory below 50° F.

The inspection of Grade A dairies is more rigid than that of Grade B dairies. There is a considerable difference in the cleanliness of barns and in the care of dairy equipment and of milk. The premium is not a reward for fortunate location; rather it is a reward for higher investment, higher costs, and a more wholesome product. Cleanliness has a market value, and Grade A producers are selling cleanliness as a service.

FIGURE 4. MODERN LABORATORY FOR INSURING HIGH QUALITY OF MILK

A special laboratory under the supervision of a trained bacteriologist is maintained at Grade A plants. There is a company inspector who devotes all of his time to Grade A dairies. It is his duty, in addition to the inspection of farms, to cooperate with the dairyman in correcting any condition which would tend to increase his bacteria count or damage the product in any way. When requested, the companies also run bacteria counts for the individual cows of any dairy, as it has been found that one abnormal cow might cause the loss of premium for the entire milk supply.

The Borden Company pays the farmers premiums according to the average weekly bacteria count as follows: if the average count for the week is below 10,000 colonies of bacteria per cubic centimeter of milk, full premium is paid; if between 10,000 and 25,000 colonies, part premium is paid; and if over 25,000 colonies per cubic centimeter, no premium is paid for milk delivered during the week. Twice each week, on days not

previously announced, samples are taken from the milk delivered by each dairyman, one sample of morning's milk and one of night's. These counts are then averaged as the basis for the premiums paid. By this company, premiums are computed on a weekly basis. If a farmer loses a premium for one week because of uncontrollable difficulties, he still has a chance of obtaining the premium for the next week if he corrects the trouble immediately.

A sediment test is run each week for each dairy. This consists of passing one pint of milk thru a special disk of cotton, which collects any foreign material that may be in the milk. In this way a check on the methods of the producers is maintained.

By the Clover Farms, Inc., and the Sheffield Farms, Inc., which also handled Grade A milk received from farmers included in this survey, premiums were paid on a monthly rather than on a weekly basis, the average count of four samples being used.

FIGURE 5. INSPECTING THE REPORTS OF BACTERIA COUNTS

Premiums are the best inducement to the production of milk of low bacteria count

The practices of handling the milk at the plant of the Borden's Farm Products Company, Inc., at Oxford, New York, where the milk from a number of farms included in this study was delivered, are as follows:

1. The milk is received at a deck, weighed in vats, and processed thruout in a plant entirely separate from that in which Grade B milk is handled. A receiving inspector, whose duty it is to inspect every can of milk for flavors, odors, and temperatures, is stationed at this deck.

2. The milk is weighed in large tanks and passes directly from them into glass-lined storage tanks which are refrigerated with brine. Milk cannot be pasteurized as fast as it is received, and holding it at a low temperature prevents bacteria from developing. From these glass-lined storage tanks the milk then passes thru the pasteurizer, where it is heated to from 142° to 145° F., to the holders, where it is maintained at a temperature of from 142° to 145° F. for 30 minutes.

3. From the holders the milk passes thru the cooling coils, where it is cooled down to a temperature of about 40°.

4. The milk then passes from the cooling coils into the bottles. They are filled and capped by machine. The milk is secured in the bottle by the use of a plug cap, and an outside Grade A hood is clamped on the bottle with a wire. This protects the lip of the bottle from any contamination on its way to the consumer, and assures him that the package has not been tampered with. During the process the milk does not come in contact with any open or uncovered receptacle.

The bottles are passed thru a power bottle-washing machine. While on their trip thru this machine they receive the following treatment:

1. A cold-water rinse under 60-pound water pressure.

2. A warm-water wash with soap and alkali solution under a pressure of 30 pounds.

3. A rinse with water at a temperature of 120° F.

4. A rinse with water at 160° F.

5. A sterilization with water at 220° F.

6. An inspection with electric lights, whereby any stained, rusty, or broken bottles are discovered and removed.

Every pipe, pump, tank, or receptacle is taken apart daily, and is first rinsed with cold water, entirely washed with a soap-powder solution, and then rinsed and sterilized. All equipment, after cleaning and sterilizing, is inspected by a sanitary inspector at the factory. After sterilizing, the drip water is run for bacteria content to see that all equipment is sterile. All milk-room doors in this factory are self-closing, and all doors and windows properly screened to exclude flies. Walls and ceilings are well painted and kept clean by washing or repainting whenever necessary.

All temperatures of milk during pasteurizing are registered by recording thermometers. The temperature in the sterilizing sections of the bottle-washer are likewise recorded. These temperature records are filed and are available for supervisor's inspection at any time.

A brine solution, coming from a refrigeration plant, is used in cooling the milk. Most of the ice for holding the temperature after loading in the cars is produced by this plant.

All employees must pass a medical examination before given employment, to ascertain whether or not they have any contagious diseases. A private laundry is maintained for the laundering of the white uniforms of all men employed in the plant. Each man has a clean suit every day. Each room is equipped with individual towels and hand-washing facilities.

Each machine is run by a separate electric motor. The use of electricity eliminates the oil, grease, and odors of gasoline and steam engines, thereby further protecting the milk from contamination.

After the bottles are filled and ready for the consumer, they are rigidly inspected, to detect any bottles that may not be in proper condition. Then the milk is taken out of the factory by conveyers and loaded in refrigerator cars, where each case is covered with crushed ice to insure proper refrigeration on its way to the city. It must reach the city terminals at a temperature below 50° F.

On January 1, 1923, according to reports of the New York City Department of Health, there were about 3600 dairies producing milk sold as Grade A, pasteurized, supplying a demand of about 250,000 quarts daily in New York City, or about 10 per cent of all the fluid milk used.

On December 15, 1922, the plants approved by the City Department of Health for handling Grade A milk were located as follows:

Amenia	Bloomville	Candor
Apulia	Boonville	Carmel
Billings	Bullville	Castorland
Blooming Grove	Burnside	Chappaqua

Circleville
Cobleskill
Coleman Station
Copake
Cortland
Dover Plains
Dryden
East River
Ferrisburg (Vermont)
Florida
Fort Ann
Fort Edward
Foster (Pennsylvania)
Gansevoort
Gracie
Grand Gorge
Hillsdale
Homer
Howe Cave
Kingsley (Pennsylvania)
Kipps Station
Johnsonburg
Lakewood (Pennsylvania)
Lime Rock (Connecticut)
Locke
Lowville
Malone
Marathon
Neelytown
New Milford
Newton
North Chatham
Otego
Otterkill
Owego
Oxford
Papakating (New Jersey)
Pine Bush
Pine Island
Portlandville
Port Leyden
Poultney (Vermont)
Richmondville
Roxbury
Salt Point
Schekomeko
Schenevus
Smithboro
Smith's Basin
Smyrna
South Gilboa (Evans Dairy Co.)
South Gilboa (Sheffield Farms)
South Kortright (Dairymen's League)
South Kortright (Sheffield Farms)
Stanfordville
Starlight (Pennsylvania)
State Bridge
Sugar Loaf
Thompson Ridge
Towners
Tranquility (New Jersey)
Tully
Tunnel
Ulster (Pennsylvania)
Warwick
Washington Depot (Connecticut)
Washingtonville
Wassaic
Wells Bridge
Whitehouse (New Jersey)
Whitney Point
Windsor
Wingdale
Wisner
Woodruff's Gap (New Jersey)

FIGURE 6. AN EFFECTIVE BRAND NAME

FIGURE 7. SHEFFIELD'S GRADE A BRAND NAME

Such brand names are good business assets

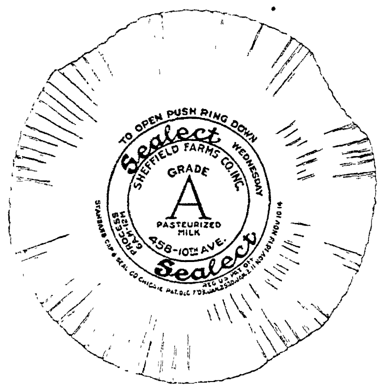

FIGURE 8. GRADE A HOOD

The three companies purchasing the Grade A milk from the farmers included in this survey sell it under the brand names of HomeRmilk, sold by the Clover Farms, Inc.; Sealect, sold by the Sheffield Farms Company, Inc.; and Borden's, sold by the Borden's Farm Products Company. These trade marks are reproduced in figures 6, 7, 8, and 9.

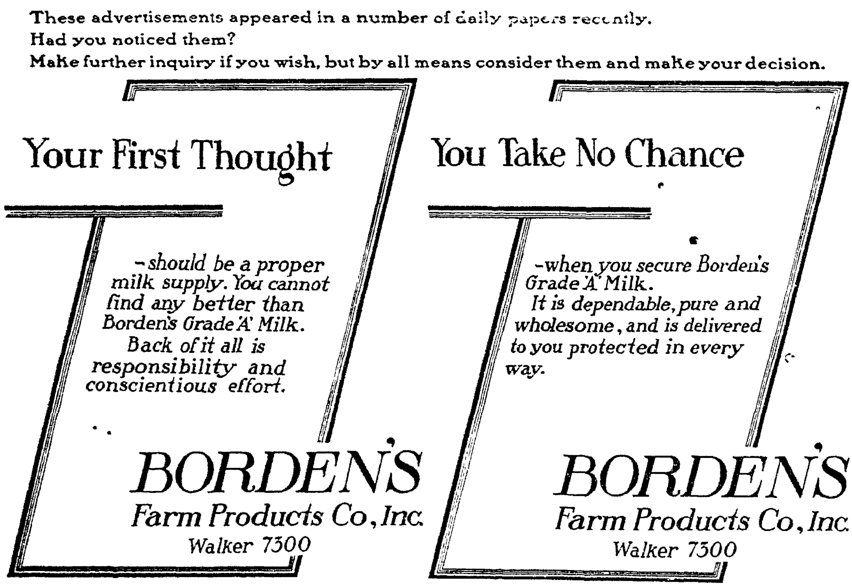

FIGURE 9. EFFECTIVE NEWSPAPER ADVERTISING OF A HIGH-QUALITY PRODUCT, THE PRIMARY WAY OF MAKING IT KNOWN TO THE PUBLIC

The plants at which the Borden's Farm Products Company, Inc., paid a premium for low bacteria count in September, 1922, and the freight zones in which these plants are located, are given in table 2.

TABLE 2. LOCATION OF BORDEN'S GRADE A PLANTS IN 1922

Plant	Freight charge per 40-quart can	Miles from New York City
Sugar Loaf	$0.305	50 to 60
Washingtonville	0.320	60 to 70
New Milford	0.320	60 to 70
Wisner	0.320	60 to 70
Kipps Station	0.320	60 to 70
Burnside	0.320	60 to 70
Florida	0.320	60 to 70
Warwick	0.320	60 to 70
Pine Bush	0.330	70 to 80
Papakating	0.330	70 to 80
Wassaic	0.355	90 to 100
Stanfordville	0.385	120 to 130
Kingsley	0.430	170 to 180
Fort Ann	0.475	220 to 230
Gansevoort	0.475	220 to 230
Brisben	0.480	230 to 240
Oxford	0.480	230 to 240
Cortland	0.485	240 to 250
Otego	0.505	260 to 270
Schenevus	0.505	260 to 270
Tunnel	0.505	260 to 270
Wells Bridge	0.505	260 to 270
Dryden	0.545	320 to 330

The actual distance of the plant from the city terminal does not necessarily correspond to the mileage used in computing freight.

The plants operated by the Sheffield Farms Company, Inc., handling Grade A milk in March, 1922, were located as follows:

Amenia
Billings
Blooming Grove
Bloomville
Bullville
Cobleskill
Coleman Station
Dover Plains
Grand Gorge
Hillsdale
Lakewood (Pennsylvania)
Lowville
Richmondville
South Gilboa
South Kortright
Tully
Ulster (Pennsylvania)

The plants operated by the Clover Farms, Inc., handling Grade A milk, were at Afton, Homer, and Schekomeko, New York.

Complete data for all Grade A plants are not available; however, the amount of fluid milk received at 60 Grade A plants was found to be 7.4 per cent of the amount of milk received at 1303 plants in New York State in 1922, or 16 per cent of all milk received in counties where Grade A plants are located.[4]

Not all milk received as Grade A is shipped as such. In order to supply the demand at all times, the buyer must carry a surplus of this grade of milk, some of which must be sold as Grade B or used in other ways. Some reasons for having this surplus are:

1. The dairies supplying this grade of milk do not produce seasonally according to the demand.

[4] New York State Department of Farms and Markets, Bulletin 158, 1923, p. 70.

2. The Department of Health may debar the milk from any factory which fails at any time to pass inspection. To have sufficient milk to supply the demand in case any plant should unexpectedly be excluded, more milk must be purchased than that called for by the current demand.

3. The distributor must be able to supply the maximum demand at all times. This varies with hot weather, holidays, and summer vacations, probably more for Grade A milk than for Grade B.

4. Grade A milk must be sold within 36 hours after pasteurization. The distributor must bring to the city a " margin of safety " to guard against delay in transit, for the milk must be served on time each day.

5. Time is required to get farms in condition to meet the requirements for this grade of milk. To meet a continuous increase in demand, distributors must keep production in advance of current needs.

Altho the companies purchasing Grade A milk necessarily have a surplus during the spring months, the premiums are paid during this period, but they are lower than for other months. Dairymen have a large proportion of their cows freshening in the spring, and the extra stimulus to production that comes when cows are turned on the pastures results in the largest surplus at this time. Companies wish to encourage producers to exercise the proper precautions at all times for Grade A milk, but at the same time they do not wish to unduly encourage production during the grass months. These premiums were paid as indicated in table 3.

TABLE 3. PREMIUMS PER 100 POUNDS PAID FOR GRADE A MILK

Month	Cents per hundred pounds of milk	
	10,000 colonies or less of bacteria per cubic centimeter of milk	From 10,000 to 25,000 colonies of bacteria per cubic centimeter of milk
1921:		
May	25	15
June	25	15
July	40	25
August	40	25
September	40	25
October	40	25
November	40	25
December	40	25
1922:		
January	40	25
February	40	25
March	40	25
April	25	15

The experience of one of the companies handling this grade of milk is that when their entire metropolitan trade is considered, only about three-fourths of the milk for which premiums are paid is actually shipped to

cities as Grade A milk. The proportion ranged from 61 per cent in June to 91 per cent in August. In other words, in June less than two-thirds of the milk for which premiums were paid is actually sold as Grade A milk, while in August nearly the entire amount can be so disposed of (table 4).

TABLE 4. Proportion of Milk for Which Grade A Premiums are Paid, That Is Actually Sold as Grade A Milk — One Company

Year	Percentage sold
1921:	
May	74
June	61
July	83
August	91
September	84
October	82
November	84
December	77
1922:	
January	69
February	62
March	68
April	71
Average for year	74

The Oxford and Brisben plants are advantageously located on the Delaware, Lackawanna and Western Railroad, so that they can conveniently ship their Grade A product to Newark and Montclair, New Jersey. In seasons of high production, these two plants can meet the demands of these towns practically unaided. In the months of low production, the shortage must be obtained from other less conveniently located plants. The situation here, however, is not typical of the experience of the company when the entire metropolitan trade is considered.

REGIONAL CONDITIONS

Of the 135 farms included in this study, 84 were in Chenango County in the vicinity of Oxford and Brisben and delivered milk to the Borden's Farm Products Co. plants in these two villages. These farms comprise the group without cash crops. The sale of crops from them brought a very small income and was not a leading feature of the business organization.

The remaining 51 farms were in the vicinity of Homer, Cortland County, and Tully, Onondaga County, 22 delivering to the Clover Farms, Inc., at Homer and 29 to the Sheffield Farms Co., Inc., at Tully. The latter company did not begin the payment of Grade A premiums at Tully until July of 1921, but the other companies have been handling Grade A for some years at the plants mentioned. These farms comprise the group with cash crops. Cabbage, potatoes, peas for the cannery, and hay are important sources of their income.

According to Dr. G. F. Warren (in Bulletin 416 of this experiment station, 1923, pages 5 and 61), when the five-years averages for the years 1910 to 1914 are taken as 100, the index numbers of wholesale prices in the United States averaged 144 for the twelve months covered by this study, the milk prices paid to producers at Utica, New York, averaged 141, and the weighted average of prices paid to New York producers for products commonly produced in the State was 141.

CHENANGO COUNTY

The soils of the 84 farms near Oxford and Brisben were mostly of the Lordstown, Wooster, Volusia, or Lackawanna series, deficient in lime and not rich in organic matter (table 5).

TABLE 5. SOIL TYPES ON THE 84 OXFORD FARMS

Type	Acres	Per cent	Per cent of each type in Chenango County as given in soil survey report
Lordstown silt loam	2,555	15.7	28.3
Wooster silt loam	2,171	13.4	19.6
Wooster gravelly silt loam	1,937	11.9	3.2
Volusia silt loam	1,470	9.0	14.2
Lordstown stony silt loam	1,228	7.6	6.6
Chenango gravelly silt loam	1,068	6.6	3.0
Lackawanna silt loam	1,050	6.5	3.8
Wooster stony silt loam	1,007	6.2	2.7
Volusia stony silt loam	899	5.5	6.0
Fox gravelly loam	659	4.1	1.3
Lackawanna stony silt loam	614	3.8	3.5
Norwich stony silt loam	480	3.0	1.3
Genesee silt loam	408	2.5	1.4
Holley silt loam	320	2.0	0.9
Chenango silt loam	150	0.9	0.3
Meadow	121	0.7	2.1
Norwich silt loam	63	0.4	0.5
Fox fine sandy loam	28	0.2	0.2
All other types	......	......	1.1
Total	16,228	100.0	100.0

The average date for the last killing frost in the spring, for the 51 years ending with 1913, at Oxford, at an elevation of 976 feet, was May 17, and the first in the fall was September 24, making a growing season of 130 days.

The average annual precipitation for the same period was 40.52 inches, of which 17.83 inches came in the growing months, from April to August inclusive.

The topography of the valley farms was a limited amount of level bottom crop land and much steep hillside pasture; and of the upland farms, rolling or steep crop and pasture land with many large stones.

FIGURE 10. VALLEY CONDITIONS AT OXFORD, NEW YORK

The average elevation of the Oxford farms was 1214 feet above sea level. Of the farms 55 were on the uplands and 29 in the valleys.

CORTLAND AND ONONDAGA COUNTIES

The area in Cortland County selected for this study was the town of Homer, in which 22 records were taken, and the area in southern Onondaga County was included in the towns of Tully and Otisco, where 29 records were taken. The elevation of these valleys is about 1100 feet and of the hilly uplands from 1500 to 1800 feet. Of the 51 farms studied, 37 were on the uplands and 14 in the valleys, the average elevation of the farms being 1369 feet.

The average dates for the last killing frost in the spring and the first in the fall at Cortland, 1129 feet above sea level, are May 14 and September 30, respectively, giving a growing season of 139 days.

The average annual precipitation at the same station for thirty-eight years was 39.57 inches, 19.10 inches falling in the five growing months, or from April to August inclusive. This is the heaviest growing-season rainfall for any of the areas studied. Another important feature of the distribution of rainfall is that in May, June, and July, the most important months of the growing season for determining crop yields, there is a rainfall of 12.47 inches.

Just south of the village of Tully the valley of the Tioughnioga begins, extending south thru Preble to Cortland. The soil is a calcareous glacial outwash till which has come largely from the terminal moraine located north of Tully and abounding in limestone fragments. It is mapped as the Fox series. On the slopes and hills the Wooster, Lordstown, and Volusia series predominate.

Of the Homer farms 9 were on the upland types of soils, mostly Lordstown stony silt loam and Lordstown silt loam; 13 were so situated that most of the crop land was Fox gravelly silt loam or Genesee silt loam. Of the farms about Tully all but 2 were in Onondaga County, where no recent soil survey has been made. Of these, 9 were so located that most of the crop land was Fox gravelly silt loam, while the remaining 20 were upland farms, most of which were located on what is probably Ontario gravelly silt loam.

The main valley roads leading to the milk stations in both areas are mostly macadam, or other well-improved roads. The dirt roads are generally in much better condition in these regions than in those with heavy soil and level topography.

The farms are fairly well maintained in both the regions studied. The additional income from the sale of crops has made it possible for some of the farmers to improve their properties more than others. Making improvements is one of the ways of saving on a farm, with certainty that the account will not be disturbed until the property is sold.

The educational facilities may be found in high schools at Oxford, Homer, and Tully. Oxford is about 30 miles south of Colgate University, and Tully is 35 miles and Homer 25 miles north of Cornell University.

The impression that one would form in passing through the section is that the farmers are prosperous. A small proportion of the farms are operated by tenants, and some of the farms operated by owners have remained in the same family for many years. In the cash-crop region the high prices received for crops during the period of the war enabled some farmers to reduce their obligations more quickly than could those who sold milk alone. The advantage of raising and selling cash crops over exclusive dairying was probably greater during the period of the war than at times of normal prices.

AGE, TENURE, AND WAGES

Of the 84 Oxford operators, 20 had attended high school for an average of 2.5 years, none had attended business school, and 1 had attended college for two years. Of the 51 Tully and Homer operators, 12 had attended high school for an average of 2.6 years, 1 had attended business school, and 3 had attended college for an average of 2.3 years. The remaining farmers had not gone beyond the district school. The average age of the Oxford operators was 47 years, of the others 45 years, and of all 46 years.

Of the 84 Oxford farmers, 66 were owners, 13 were share tenants, and 3 were cash tenants. Of the 51 Tully and Homer farmers, 38 were owners and 10 were share tenants. The common method of leasing is under a half-and-half share agreement, with the landlords usually furnishing more than half the cattle. Three farms in the latter region were operated by hired foremen. The previous and the present tenure status of 130 farmers is shown in table 7. Inspection of table 6 will indicate that most of the present farmers worked as hired men on farms, and that most of them were never engaged in any occupation other than farming.

Whenever the operator did not spend twelve months on the farm, a part of the hired man's wages representing the value of the time put in by the person who acted in his place while he was away was deducted before computing the labor income.

The operators were asked to estimate the value of their time, on the basis of what it would cost to hire some one to do the work and management equally well, having a house and such other things as the farm provides toward the living necessities furnished; or what they, the operators, could obtain for similar work elsewhere with the aforementioned perquisites. Thus, the figure obtained can be compared directly with the

TABLE 6. EMPLOYMENT HISTORY OF OXFORD, TULLY, AND HOMER FARMERS

	Owner of present farm but never owner of other farms		Owner of other farms before becoming owner of present farm		Share tenants		Cash tenants
	Oxford	Tully and Homer	Oxford	Tully and Homer	Oxford	Tully and Homer	Oxford
Total number of this tenure status*	51	27	15	11	13	10	3
Number that never had been tenants	31	15	5	7		.	....
Number that had been tenants on present farm but never on other farms	10	1	2	1	5	2	1
Number that had been tenants on other farms but never on present farm	10	10	6	3	2	0	0
Number that had been tenants on other farms and on present farm	0	1	2	0	6	8	2
Total number that had worked as hired men on farms	43	24	10	6	11	8	3
Number that had worked as hired men on home farm but not on other farms	18	12	4	5	2	3	0
Number that had worked as hired men on other farms but not on home farm	16	6	4	0	8	3	3
Number that had worked as hired men on other farms and on home farm	9	6	2	1	1	2	0
Number that had never worked as hired men on farms but had been engaged in other occupations	6	3	2	5	1	2	0
Number that had neither worked as hired men on farms nor been engaged in other occupations	2	0	3	0	1	0	0
Number that had worked as hired men on farms and had been engaged in other occupations	18	3	4	2	6	1	0
Number that had worked as hired men on farms but had never been engaged in other occupations	25	21	6	4	5	7	3

* Three Tully and Homer farms operated by hired foremen. History not found for two Oxford operators.

TABLE 7. PRECEDING TENURE STATUS OF PRESENT OPERATORS

	Present tenure status						
	84 Oxford farms				51 Tully and Homer farms		
	Owners*	Share tenants†	Cash tenants	All operators	Owners‡	Share tenants	All operators
Number of farms	66	13	3	82	38	10	48
Average age of operator (years)	48	39	39	47	45	44	45
Average age at which operator began present status	36	......	......	.....	35	....	....
Average years in present status	11.9	.....	.	.....	10.0	....	....
Tenant on present farm:							
Number of farmers	14	13	3	30	3	10	13
Average age when farmer began tenancy	31	35	36	33	39	38	38
Average years in such status	6.7	5.1	3.0	5.6	8.3	6.0	6.5
Tenant on other farms:							
Number of farmers	18	8	2	28	14	8	22
Average age when farmer began tenancy	30	35	36	32	23	32	27
Average years in such status	6.7	6.0	7.0	6.5	7.0	7.1	7.0
Hired man at home:							
Number of farmers	33	3	.	36	24	5	29
Average age when farmer began as hired man	18	16	..	18	17	17	17
Average years in such status	6.0	5.7	.	6.8	6.6	8.8	7.0
Hired man away from home:							
Number of farmers	31	9	3	43	13	5	18
Average age when farmer began as hired man	18	17	15	18	19	18	19
Average years in such status	9.9	15.0	16.7	11.4	5.2	12.8	7.3
Other occupations:							
Number of farmers	30	7	.....	37	13	3	16
Average age when farmer began such occupation	22	22	......	22	21	16	20
Average years in such status	11.0	3.9	.....	9.6	15.5	13.0	15.1

* One owner's history not found. † One share tenant's history not found. ‡ Three owners' farms operated by hired managers.

labor incomes, the purpose being chiefly to discover how the amount that they actually received compared with the amount that they considered they deserved.

A study of the variations in these estimates (table 8) shows that one-fourth of the Tully and Homer farmers valued their time at $1500 or more, and about one-sixth at less than $900. Of the Oxford farmers, 60 per cent were less than $900 and one was as high as $1500.

TABLE 8. VARIATIONS IN ESTIMATES PLACED BY 135 FARM OPERATORS ON THE VALUE OF THEIR TIME FOR TWELVE MONTHS

Value of operator's labor	84 Oxford farms		51 Tully and Homer farms	
	Number of farms	Per cent	Number of farms	Per cent
$ 450	1	1.2	....	....
475	1	1.2	....	....
480	1	1.2	....	....
500	2	2.4	....	....
600	16	19.0	3	5.9
648	1	1.2	....	....
684	1	1.2	....	....
700	3	3.6	....	....
720	13	15.4	5	9.8
730	1	1.2	....	....
753	1	1.2	....	....
800	4	4.7	....	....
802	1	1.2	....	....
840	2	2.4	....	....
850	....	....	1	2.0
862	1	1.2	....	....
870	1	1.2	....	....
900	13	15.5	9	17.6
907	1	1.2	....	....
950	....	....	1	2.0
1,000	6	7.1	2	3.9
1,025	1	1.2	....	....
1,100	1	1.2	....	....
1,170	....	....	1	2.0
1,200	10	11.9	15	29.4
1,280	....	....	1	2.0
1,440	1	1.2	....	....
1,500	1	1.2	7	13.7
1,800	....	....	2	3.9
1,825	....	....	1	1.9
2,000	....	....	3	5.9
Total	84	100.0	51	100.0

The average value placed by the farm operators on their time for twelve months, covering board but not privileges, was $826 for the Oxford and $1170 for the Tully and Homer group. The average time spent by the Oxford operators was 11.4 months per farm, and by the others 11.8 months per farm. The average value of the 135 operators' time was $956 for twelve months, or $80 per month.

TABLE 9. LABOR ON 84 OXFORD FARMS

	Number of farms using	Months worked			Value of unpaid labor		Total wages		Average per month worked		
		Total	Per cent	Per farm	Total	Average per month	Cash	Board	Cash	Value of board	Total
Operator's wife:											
Unpaid	58	193	15.9	3.3	$9,526	$49.36	......	......	......	......	......
Operator's sons:											
Paid	5	77	6.4	15.4	......	......	$ 3,450	$ 466*	$44.81	$ 8 79	$53.60
Unpaid	14	110	9.1	7.9	4,976	45.24	......	......	......	......	......
Operator's daughters:											
Unpaid	11	44	3.6	4.0	1,982	45.05	......	......	......	......	......
Operator's other relatives:											
Paid	4	29	2.4	7.2	......	......	1,010	460†	34.83	16.43	51.26
Unpaid	8	35.5	2.9	4.4	1,610	45.35	......	......	......	......	......
Second operator	1	12	1.0	12.0	900	75.00	......	......	......	......	......
Landlord	2	2.2	0.2	1.1	110	50.00	......	......	......	......	......
Hired man by month:											
Without board	9	71.5	5.9	7.9	......	......	4,408	......	61.65	......	61.65
With board	47	552.6	45.6	11.8	......	......	23,115	9,066	41.83	16 41	58.24
Hired man by day:											
Without board	23	26.6	2.2	1.2	......	......	1,892	......	71.13	......	71.13
With board	28	34.5	2.8	1.2	......	......	2,188	431	63.42	12.49	75.91
Other help:											
Paid	2	22	1.8	7.3	......	......	380	464‡	23.75	21.09	44.84
Unpaid	1	2	0.2	2.0	80	40.00	......	......	......	......	......
Total labor, except operator	84	1211.9	100.0	14.4	$19,184	$48.12	$36,443	$10,887	$45.15	$15.78	$58 20
Operator	84	954	......	11.4	66,164	69.35	......	......	......	......	......
Share of other help in absence of operator	10	54	......	5.4	3,202	59.30	......	......	......	......	......
Total for 12 months time, operator	84	1008	......	12.0	$69,366	$68.82	......	......	......	......	......
Man equivalent	......	......	......	2.20	......	......	......	......	......	......	......

* Board was furnished for 53 months on 4 farms. † Board was furnished for 28 months on 3 farms. ‡ Board was furnished for 22 months on 3 farms.

TABLE 10. LABOR ON 51 TULLY AND HOMER FARMS

	Number of farms using	Months worked			Value of unpaid labor		Total wages		Average per month worked		
		Total	Per cent	Per farm	Total	Average per month	Cash	Board	Cash	Value of board	Total
Operator's wife:											
Paid	1	1	0.1	1.0	......	......	$ 60	......	$60.00	......	$ 60.00
Unpaid	13	32.5	3.5	2.5	$ 2,023	$ 62.25	......	......	......	......	....
Operator's sons:											
Paid	5	55	5.9	11.0	......	......	2,470	$ 964*	44.91	$22.42	67.33
Unpaid	16	254	27.1	15.9	16,006	63.02	......	......	......	......	....
Operator's daughters:											
Unpaid	1	1	0.1	1.0	20	20.00	......	......	......	......	....
Operator's other relatives:											
Unpaid	2	8	0.8	4.0	650	81.25	......	......	......	......	....
Second operator	3	36	3.8	12.0	2,620	72.78	......	......	......	......	....
Landlord	1	2	0.2	2.0	200	100.00	......	......	......	......	....
Hired man by month:											
Without board	13	122	13.0	9.4	......	......	8,473	......	69.45	......	69.45
With board	40	388.8	41.4	9.7	......	......	20,841	8,624	53.60	22.18	75.78
Hired man by day:											
Without board	1	19	2.0	19.0	......	......	912	......	48.00	......	48.00
With board	9	13.7	1.5	1.5	......	......	1,220	391	89.05	28.54	117.59
Other help:											
Unpaid	2	5.5	0.6	2.8	290	52.73	......	......	......	......	....
Total labor, except operator	51	938.5	100.0	18.4	$21,809	$64.33	$33,976	$9,979	$56.67	$22.40	$73.32
Operator	51	603	......	11.8	58,925	97.72	......	......	......	......	......
Share of other help in absence of operator	3	9	......	3.0	750	83.33	......	......	......	......	......
Total for 12 months time, operator	51	612	......	12.0	$59,675	$97.51	......	......	......	......	......
Man equivalent	......	......	......	2.53	......	......	......	......	......	......	......

* Board was furnished for 43 months on 4 farms.

The average cash wage paid monthly to hired men without board was \$61.65 on the Oxford farms and \$69.45 on the others; for hired men with board furnished the monthly wage amounted to \$41.83 on the Oxford farms and \$53.60 on those of the other group (tables 9 and 10). The cash value of board furnished, excluding the part furnished by the farm, averaged \$16.41 per month on the Oxford farms and \$22.18 on the others.

Most Oxford hired men are unmarried and have their board furnished. On the Tully and Homer farms the proportion of the hired laborers who were married and furnished their own board was greater than on the Oxford farms.

The average number of persons equivalent to men, computed on a yearly basis of the amount of work (man equivalent), was 2.2 for the Oxford and 2.53 for the Tully and Homer farms. On the Oxford farms 45.4 per cent of the labor was time of the operators, 22.0 per cent that of the operators' families, and 32.6 per cent that of workers hired outside of the operators' families. On the Tully and Homer farms a larger proportion of the labor was performed by hired help, as the farms carried on a larger business.

FARM CAPITAL

Farms with less than 12 cows at the end of the year studied were not included. This selection results in an average size of farm somewhat larger than the regional averages, but, since the study was concerned primarily with dairy farms, this limit was set.

In making a farm management survey, the purpose may be to make an economic study of a region, or it may be to make such a study of the various systems of farming in a region. If the first is the object, all farms should be included in order to get a typical and complete record of the area. If, however, the object is to study systems of farming, one is justified in excluding those types of farming which are not to be studied, and in seeking such areas that will give the desired information, as was done in this study.

TABLE 11. AVERAGE SIZE OF 135 FARMS

	84 Oxford farms		51 Tully and Homer farms	
	Average acres per farm	Per cent of total acres	Average acres per farm	Per cent of total acres
Crop land	63.6	32.8	75.3	44.8
Woods pastured*	26.3	13.6	12.9	7.7
Rotated pasture	0.4	0.2	3.8	2.3
Permanent pasture tillable	15.2	7.8	25.9	15.4
Other permanent pasture	68.3	35.2	35.7	21.2
Woods not pastured	12.5	6.4	6.3	3.7
Farmstead, roads, and so forth	7.8	4.0	8.3	4.9
Total	194.1	100.0	168.2	100.0

* Equivalent in open pasture of 5.5 acres for Oxford farms and 4.2 acres for Tully and Homer farms.

The average size of the 84 Oxford farms was 194 acres, with about one-third in crops; while the average size of the Tully and Homer farms was 168 acres, with 75 acres, or 45 per cent of the total, in crops (table 11). In the latter regions, therefore, less of the land is in woods and untillable pasture, and more of it in crop land, rotated pasture, and tillable pasture. This makes possible the raising of cash crops, such as peas for canning, cabbage, and potatoes, with the dairy enterprise in the Tully and Homer region, while the Oxford farms depend almost exclusively on the dairy for their income.

The average total capital for the Oxford farms was $13,040, 68.2 per cent of which was in the farm; and for the Tully and Homer farms $19,204, 71.2 per cent of which was in the farm (table 12). About one-fifth of the capital was in livestock, and one-tenth in machinery and equipment.

TABLE 12. AVERAGE CAPITAL FOR 135 FARMS

	84 Oxford farms		51 Tully and Homer farms	
	Value per farm	Per cent of total	Value per farm	Per cent of total
Real estate	$8,887	68.2	$13,681	71.2
Livestock	2,757	21.1	3,466	18.1
Machinery	1,277	9.8	1,766	9.2
Feed and supplies	119	0.9	291	1.5
Total	$13,040	100.0	$19,204	100.0

The Oxford farms had an average value of $46 an acre, and the others $81. Land is more expensive around Tully and Homer, chiefly because a larger proportion of it is tillable, cash crops are added to the system of farming, the topography is more favorable, and the markets in general are better.

The distribution of the real-estate capitalization in the two areas is shown in table 13.

The question might be raised whether the farms should not be considered overcapitalized when, after deducting the estimated value of the farmers' best alternatives from the net receipts, the result is less than the current rates of interest on the appraised value of the properties. Before answering this question, it is well to remember that a fair capitalization of any business cannot be made from a single year's earnings, and also that there is considerable uncertainty as to the precision of the value placed on their time by these men as a group. A shifting of the entire group into some other occupation, aside from being out of the question, even if it could be done, would lower the earnings afforded by the other occupation.

The cumulative investment in a property cannot be used as an indication of what its fair capitalization should be for business purposes. Uneconomical expenditures for buildings or other improvements cannot be expected to compete in net revenues with improvements that result in equal earnings but at much less investment. The selling value, and

TABLE 13. DISTRIBUTION OF FARM REAL-ESTATE CAPITAL

	84 Oxford farms		51 Tully and Homer farms	
	Value per farm	Per cent of total	Value per farm	Per cent of total
Dwelling no. 1	$1,476	16.5	$2,016	14.4
Dwelling no. 2 (19 farms)	195	2.2	414*	3.0
Cattle barn	2,048	23.0	3,199	22.9
Barn no. 2 (33 farms)	288	3.2	327†	2.4
Other buildings	519	5.8	1,004	7.2
Total buildings	$4,526	50.7	$6,960	49.9
Orchard	$ 29	0.3	$ 25	0.2
Crop land	2,416	27.1	4,502	32.2
Pasture land, except woods pastured	1,388	15.5	1,696	12.1
Woodland	542	6.1	761	5.5
Other land	28	0.3	15	0.1
Total land	$4,403	49.3	$6,999	50.1
Total value of farm (land and buildings)	$8,929	100.0	$13,959	100.0

* Only 12 farms had more than one dwelling.
† Only 18 farms had more than one main barn.

not the cost of a property, is therefore used for its capitalization. There is no way of proving that the farms would actually change possession at the values placed on them. In some instances the farms had been purchased recently at the prices included. The average value of land and buildings, according to the 1920 United States census,[5] was, for Chenango County, $5048, or $37.78 per acre, and for Cortland County, $5817, or $47.68 per acre. By comparing these values with those of ten years before, it is seen that the farms have increased in value 36 and 50 per cent, respectively, for the two counties. Much of this increase is due to investment of labor or cash in buildings, fences, and water systems, increased fertility, and other types of improvements.

The value of the farms is in the main determined by earning power. Earning power, in turn, is dependent upon productive soil, good markets, and skillful farmers. It is probable that differences in the first two conditions account largely for the difference in land values between the two regions.

The total real capital of the Tully and Homer farms, which averaged 26 acres smaller than the Oxford farms, was $5,030, or 56 per cent more than the Oxford farms. Of this $2434 was in greater building capitalization, and the remainder in land. The value of buildings per farm was 54 per cent more, of crop land per acre 57 per cent more, and of pasture land 57 per cent more on the Tully and Homer farms than on the Oxford farms.

Of the total capital in land and buildings, about one-half was in buildings in each area, and one-half in land. Around Oxford the average values per acre for land were: crop land, $37.96; pasture land, $16.54; and

[5] Fourteenth census of the United States, vol. 6; part 1 (1919): Agriculture, p. 211. 1922.

woodland, $13.96. For the Tully and Homer farms the values per acre were: crop land, $59.77; pasture land, $25.93; and woodland, $39.65.

The question of turnover of capital is one that is often looked upon by bankers and industrial financiers as a matter of considerable importance. The data in tables 14, 15, and 16 show a comparison of the turnover of capital on dairy farms, in corporations engaged chiefly in handling milk and milk products, and of feed dealers.

The data for 215 New York dairy farms are given in table 14. The total of the business assets is the total capital of the land, livestock, equipment, and supplies for these farms. The net assets are not known, because no information as to the liabilities of these farms was obtained. The gross sales represent total sales of milk, crops, livestock, and miscellaneous items, data for which are presented in this bulletin and in Bulletin 421 of the Cornell University Agricultural Experiment Station. The operating expenses also are included in the same bulletins.

TABLE 14. TURNOVER OF CAPITAL ON 215 NEW YORK DAIRY FARMS FOR THE YEAR ENDING APRIL 30, 1922

Total business assets	$3,148,981
Gross sales:	
Crops	100,418
Milk:	
Cash	656,244
Certificates of indebtedness	33,525
Livestock	96,485
Miscellaneous items	46,177
Total gross sales	$932,849
Operating expenses	$710,694
Value of time for one year of 215 farm operators	$201,711
Net income for interest and surplus	$20,444
Percentage of assets represented by net income for interest and surplus	0.65
Ratio of gross sales to assets (per cent)	29.6
Average labor income per farm	$301
Percentage of gross sales represented by net income for interest and surplus	2.2

The value of the time of operators is mostly a wage value for their manual labor. At prevailing wages for hired men with a house and products furnished, the cost to hire men in their places would have been 76 per cent of the value of the operators' time. But the hired men would not have done the job so well. When the time of operators is charged, as officers' salaries would be in a corporation, there was a return of two-thirds of one per cent on the capital. Slightly over three years would be required for sales to equal the capital.

The two companies for which data are given in table 15 are large milk-manufacturing and milk-distributing corporations. Their business is not production, but chiefly the handling of milk and its products. As given in Moody's Manual, the net income is 10.5 and 2.5 per cent, respectively, of the business assets. The sales are about twice the total business assets, as compared with sales from farms of less than one-third of the total

business assets. Agriculture is a business requiring long-time investments with a very slow turnover of capital, compared with most manufacturing industries.

TABLE 15. TURNOVER OF CAPITAL FOR TWO LARGE MILK AND MILK-PRODUCTS CORPORATIONS FOR THE YEAR ENDING DECEMBER 31, 1922*

Company no. 1	
Total capital stock, reserves, and surplus	$49,501,418
Gross sales	$92,058,760
Net income for dividends and surplus	$5,173,749
Dividends	$2,194,770
Appropriation for reserves	$ 730,872
Surplus for year	$2,248,107
Percentage of assets represented by net income	10.5
Ratio of gross sales to capital stock, reserves, and surplus (per cent)	186.1
Percentage of gross sales represented by net income	5.6
Company no. 2	
Total business assets	$17,130,948
Net sales	$34,611,885
Net income for dividends and surplus	$434,733
Dividends	$350,000
Surplus for year	$84,733
Percentage of assets represented by net income	2.5
Ratio of net sales to assets (per cent)	202.0
Percentage of net sales represented by net income	1.3

* From data in *Moody's Analyses of Investments and Security Rating Books. Industrial Securities.* By John Moody, 1923, p. 1015 and 2081. Also from the fourth annual report of Company no. 1.

The ratio of gross sales to the total business assets for 37 privately owned feed stores in New York is shown in table 16. The rate of turnover of capital for these stores is about two and one-half times the capital, or about 25 per cent larger than the average of the two milk companies. Apparently, feed dealers and milk-handling concerns turn over their capital about six to eight times as fast as do milk producers.

TABLE 16. CAPITAL TURNOVER FOR THE YEAR 1921 FOR 37 FEED STORES OWNED PRIVATELY*

Total business assets	$1,269,285
Total sales	$3,155,804
Ratio of gross sales to assets (per cent)	248.6

* An economic study of rural store credit in New York. By Leland Spencer. Cornell Univ. Agr. Exp. Sta., Bul. 430, 1924, p. 31-32.

The interests of the milk distributer and of the producer should be mutual. Competition on the selling end in the city forces the distributer to keep the price paid to the producer as low as he can and still get a sufficient supply of milk for the demands of his trade. The reason why he can get the supply at the prices he pays, and the unfortunate part

of the situation from the producer's standpoint, is that a large volume of milk is produced on land on which no interest is reckoned or paid. Production continues under these conditions by the operator living from an income which represents no more than interest on the present capitalization of the farm and equipment. The price of milk will not allow the dairy farms of New York to be operated on capital borrowed on the basis of their present estimated values.

The variation in the size of farms was as follows: Oxford area, less than 75 acres, 5; from 75 to 124 acres, 19; from 125 to 174 acres, 17; from 175 to 250 acres, 22; over 250 acres, 21. Tully and Homer area, same grouping, 2, 14, 15, 15, and 5, respectively.

The number of cows per farm ranged from 10 to 68 on the Oxford farms and from 10 to 60 on the Tully and Homer farms.

The proportion of farms employing 2.5 men or over with less than 30 cows was larger in the Tully and Homer area than in the Oxford area, because of the crop work.

The total capital ranged from $3594 to $41,274 on the Oxford farms. On 37 farms the total capital was less than $10,000, on 35 farms from $10,000 to $20,000, on 8 from $20,000 to $30,000, and on 4 over $30,000. The total capital ranged from $7636 to $49,650 on the Tully and Homer farms. On 3 it was less than $10,000, on 28 from $10,000 to $20,000, on 13 from $20,000 to $30,000, and on 7 over $30,000.

FARM RECEIPTS

The total receipts per farm for the Oxford farms were $4161 and for the Tully and Homer farms $7018 (table 17). The difference was due chiefly to the addition of crop sales of $1600 per farm, increase in value of property due to improvements, the sale of 161 hundredweight more of milk per farm, and the pooling of a smaller proportion of the milk, all milk bringing an average price of 19 cents more per hundred pounds.

TABLE 17. AVERAGE RECEIPTS PER FARM

	84 Oxford farms		51 Tully and Homer farms	
	Average per farm	Per cent of total	Average per farm	Per cent of total
Crops sold	$ 71	1.7	$1,671	23.8
Livestock sold	479	11.5	550	7.8
Milk sold:				
Cash	3,102	74.6	3,856	54.9
Certificates of indebtedness*	187	4.5	110	1.6
Increase in inventory	64	1.5	601	8.6
Miscellaneous	258	6.2	230	3.3
Total	$4,161	100.0	$7,018	100.0

* Of the Dairymen's League Cooperative Association, Inc.

The crops grown, the yields per acre, and the receipts from crops sold in the two areas, are given in table 18.

TABLE 18. CROPS RAISED ON 135 FARMS

Kind of crop	Unit	84 Oxford farms						51 Tully and Homer farms					
		Acres	Total yield	Operator's sales		Landlord's sales		Acres	Total yield	Operator's sales		Landlord's sales	
				Amount	Value	Amount	Value			Amount	Value	Amount	Value
Corn for grain	Bushels	41	2,188	75	$ 75	......	......	26	1,680	......	......	......	......
Stover from corn for grain	Tons	......	1[illegible]	......	......	......	......	......	77	......	......	......	......
Corn for the silo	Tons	490	6,480	22	91	......	......	495	6,846	......	......	......	......
Corn for the silo, surplus	Tons	21	112	9	29	......	......	6	56	......	......	......	......
Grain from corn for the silo	Bushels	......	1,251	81	31	......	......	......	60	......	......	......	......
Corn for fodder cured	Tons	25	161	......	......	......	......	13	99	......	......	......	......
Sweet corn fed green	Tons	1.5	20	......	......	......	......	1	10	......	......	......	......
Other corn fed green	Tons	26	281	......	......	......	......	13	192	12	$ 5	......	......
Oats	Bushels	332	7,644	......	......	......	......	457	17,458	600	600	......	......
Oat straw	Tons	......	228.5	10	145	......	......	......	402	......	......	......	......
Oats and barley	Bushels	......	......	......	......	......	......	271	6,758	25	17	......	......
Oat and barley straw	Tons	......	......	......	......	......	......	......	122	......	......	......	......
Oats, spring wheat, and barley	Bushels	......	......	......	......	......	......	31	1,070	......	......	......	......
Oat, spring wheat, and barley straw	Tons	......	......	......	......	......	......	......	40	......	......	......	......
Oats, peas, and barley	Bushels	......	......	......	......	......	......	21	785	......	......	......	......
Oat, pea, and barley straw	Tons	......	......	......	......	......	......	......	24	......	......	......	......
Barley	Bushels	......	......	......	......	......	......	20	394	......	......	......	......
Barley straw	Tons	......	......	......	......	......	......	......	19	......	......	......	......
Buckwheat	Bushels	21	427	82	91	......	......	24	600	180	270	......	......
Buckwheat straw	Tons	......	7	......	......	......	......	......	5	......	......	......	......
Winter wheat	Bushels	20	472	115	192	......	......	65	1,470	1,065	1,173	......	......
Spring wheat	Bushels	......	......	......	......	......	......	6	57	......	......	......	......
Wheat straw	Tons	......	23.5	5	85	......	......	......	35	3	30	......	......
Rye and vetch	Bushels	......	......	......	......	......	......	1	25	15	45	......	......
Rye and vetch straw	Tons	......	......	......	......	......	......	......	2	......	......	......	......
Oats for hay	Tons	192	261	......	......	......	......	17	37	......	......	......	......
Oats and peas for hay	Tons	53	99.5	......	......	......	......	1	2	......	......	......	......
Millet for hay	Tons	6	15	......	......	......	......	7	20	......	......	......	......
Oats and peas fed green	Tons	4	11	......	......	......	......	4.5	30.5	......	......	......	......
Oats and peas for the silo	Tons	6	28	......	......	......	......	......	......	......	......	......	......
Oats for the silo	Tons	6	13	......	......	......	......	......	......	......	......	......	......
Buckwheat fed green	Tons	4	14.5	......	......	......	......	4	12	......	......	......	......
Millet fed green	Tons	9.5	68	......	......	......	......	7	73	......	......	......	......
Millet silage	Tons	......	......	......	......	......	......	4	20	......	......	......	......
Alfalfa fed green:													
(First cutting)	Tons	......	......	......	......	......	......	2	8	......	......	......	......
(Second cutting)*	Tons	......	......	......	......	......	......	(47)	66	......	......	......	......
(Third cutting)*	Tons	......	......	......	......	......	......	(18)	16	......	......	......	......
Rowen fed green*	Tons	......	......	......	......	......	......	(22)	32	......	......	......	......
Hay fed green	Tons	......	7	......	......	......	......	......	3	......	......	......	......
Alfalfa (first)	Tons	4	8	......	......	......	......	347	655	91	1,173	20	$ 260
Alfalfa (harvested from new seeding)*	Tons	......	......	......	......	......	......	(37)	24	......	......	......	......

* These acres are not included in the total acres of crops.

TABLE 18 (*concluded*)

Kind of crop	Unit	84 Oxford farms						51 Tully and Homer farms					
		Acres	Total yield	Operator's sales		Landlord's sales		Acres	Total yield	Operator's sales		Landlord's sales	
				Amount	Value	Amount	Value			Amount	Value	Amount	Value
Alfalfa (second)*	Tons	(2)	2	......	......	......	......	(296)	324	74	$ 1,402	26	$ 442
Alfalfa (third)*	Tons	......	......	......	......	......	......	(54)	28	......	......	......	......
Mixed hay (clover)	Tons	558	1,090	0.5	$ 8	......	......	460	748	42	555	......	......
Mixed hay (other)	Tons	2,677	2,922	31	495	......	......	366	491	41.5	526	24.5	294
Timothy	Tons	724	1,165	35	638	4.0	$ 70	672	1,094	110	1,662	......	......
Rowen*	Tons	(90)	72	......	......	......	......	(53)	42	......	......	......	......
Potatoes	Bushels	76.9	9,320	2,915	2,934	545.0	570	227.9	30,759	22,637	21,446	799	722
Cabbage	Tons	1	5	5	155	......	......	170	1,724.8	1,509.8	47,387	141	4,397
Cabbage refuse	Tons	......	......	......	......	......	......	......	110	......	......	......	......
Factory peas	Cwt.	......	......	......	......	......	......	38	624	519	2,055	102	338
Pea-vine silage	Tons	......	......	......	......	......	......	......	92	4	12	......	......
Mangels	Tons	1.5	5	......	......	......	......	......	......	......	......	......	......
Field beans	Bushels	......	3	2	4	......	......	......	......	......	......	......	......
Pop corn	Bushels	0.2	20	18	45	......	......	......	......	......	......	......	......
Apples	Barrels	46.5	......	......	......	......	......	57.3	......	35	88	......	......
Cherries	Quarts	......	......	......	......	......	......	7	200	25	6	25	6
1920 corn silage sold	Tons	......	......	......	......	......	......	......	......	1	4	1	4
1920 oat straw sold	Tons	......	......	......	......	......	......	......	......	20	300	......	......
1920 hay sold	Tons	......	......	9.5	128	9.5	128	......	......	......	......	......	......
Total	......	5,347.1	......	......	$5,146	......	$768	3,841.7	......	......	$78,756	......	$6,463

* These acres are not included in the total acres of crops.

The average yields per acre for the more important crops were: For the Oxford farms, corn for the silo, 13.2 tons; oats, threshed, 23 bushels; mixed hay, clover, 2 tons; timothy, 1.6 tons. For the Tully and Homer farms, corn for the silo, 13.8 tons; oats, threshed, 38.2 bushels; mixed hay, clover, 1.6 tons; timothy, 1.6 tons; potatoes, 135 bushels; cabbage, 10.1 tons (table 19). There is little noticeable difference between the yields of the important crops in both the areas.

TABLE 19. AVERAGE YIELDS PER ACRE FOR IMPORTANT CROPS

Kind of crop	Unit	Yield per acre	
		84 Oxford farms	51 Tully and Homer farms
Corn for the silo	Tons	13.2	13.8
Oats for grain	Bushels	23.0	38.2
Oats for hay	Tons	1.4	2.2
Oats and peas for hay	Tons	1.9	2.0
Alfalfa (first)	Tons	....	1.8
Alfalfa (second)	Tons	....	1.1
Alfalfa (third)	Tons	....	0.5
Mixed hay (clover)	Tons	2.0	1.6
Mixed hay (other)	Tons	1.1	1.3
Timothy	Tons	1.6	1.6
Potatoes	Bushels	121.2	135.0
Cabbage	Tons	....	10.1
Factory peas	Hundredweight	....	16.4

The crop receipts for the Oxford farms were insignificant, averaging only $71 per farm. For the Tully and Homer farms, the average crop sales were: potatoes $435, cabbage $1015, canning peas $47, alfalfa $64, timothy and mixed hay $60, other crops $50; a total of $1671 per farm. For the Oxford farms 1.7 per cent of the total receipts were obtained from crops sold, and for the Homer and Tully farms 23.8 per cent.

Twenty-eight Oxford farms had no income from crops sold. The range in crop sales per farm was from $4 to $913 (the only one above $500) on the Oxford farms, and from $168 to $5281 on the Tully and Homer farms.

Of the 84 Oxford farms 69 had silos, 5 having two silos each, and 2 having three silos each. All except 2 of the Tully and Homer farms had silos. Of these, 17 had two and 1 had three silos. In addition to the 130 cylindrical silos, 16 rectangular silos of various dimensions were used (table 20).

While some varieties of ensilage corn are always given a trial, the majority of farmers use one of two or three leading kinds. In the Oxford area Luce's Favorite was the most popular, with Sweepstakes second and Eureka a close third (table 21). In the Tully and Homer areas, Sweepstakes was first in acreage, with Early Wonder second and Luce's Favorite third. The Tully and Homer areas grew nearly half again as much corn per farm as did the Oxford farms.

TABLE 20. SUMMARY OF THE NUMBER OF SILOS OF EACH SIZE ON 118 OXFORD, TULLY, AND HOMER FARMS

Height of silos, in feet	69 Oxford farms*								27 Tully and 22 Homer farms†									
	Diameter of silos, in feet							Total silos	Diameter of silos, in feet									Total silos
	10	12	14	15	16	17	18		12	13	13.5	14	15	16	17	18	20	
	Number of silos								Number of silos									
20	1	1						2										
22	1							1						1				1
23		1	1					2	1									1
24	2	3	2		5			12	1									1
25	1							1										
26	1	3	5		1			10	1								1	2
27		1			1			2						1				1
28	1	5	5		2			13		1		2	1	3	2			9
29		1						1										
30	1	2	4		1			8	2	1		8		9		3		23
31			2					2										
32		1	2	1	2	1	1	8	1	1	1	7		2		1		13
33													1					1
34		1			1			2				1		1	1			3
35		1						1										
36					2		1	3				1	1	1				3
39			1					1										
40					1			1						1				1
44														1				1
Total	8	20	22	1	16	1	2	70	6	3	1	19	3	20	3	4	1	60

* In addition to the round silos, there were rectangular silos, one of each of the following dimensions: 12 x 16 x 24; 14 x 14 x 10; 14 x 14 x 18; 14 x 18 x 26; 15½ x 17½ x 29½; 16 x 16 x 22; 20 x 20 x 36; 20 x 40 x 15.

† In addition to the round silos, there were rectangular silos, one of each of the following dimensions: 10 x 12 x 30; 10½ x 10½ x 32; 10½ x 14½ x 32; 12 x 15 x 28; 14 x 16 x 22; 16 x 19 x 12; 16 x 16 x 12; 17 x 17 x 26.

The crop index which expresses the yields of crops on the farms studied, compared with the average yields of the same crops in New York as nearly as can be determined from data on hand, was 103.4 for the Oxford farms and 125.1 for the Tully and Homer farms. The index for corn for the silo was 213 for Oxford and 223 for the other farms, for oats 69 and 115, and for all hay 92 and 107, respectively. The crop index resulting from weighing corn for the silo, oats, and hay according to the work units on these crops was 132 for the Oxford farms and 159 for the Tully and Homer farms. More manure, lime, and commercial fertilizer was used per acre on the latter farms, and the rainfall was heavier. The soils also are naturally more fertile, and retain moisture better. All these conditions influence crop yields.

Statements of the inventories, purchases, sales, and deaths of livestock for the two areas appear in tables 22, 23, 24, and 25.

The average number from the inventories of the most important animals per farm was: For the Oxford group, cows, 24.9; heifers one year old and over, 4; heifers under one year, 3.2; horses, 3.5; chickens, 65. For the Tully and Homer groups, cows, 24.9; heifers one year old and over, 3.3; heifers under one year, 2.7; horses, 4.6; chickens, 51.

TABLE 31. SUMMARY OF VARIETIES OF CORN FOR THE SILO, 118 FARMS

	69 Oxford farms		49 Tully and Homer farms	
	Acres	Per cent	Acres	Per cent
Luce's Favorite	207.1	42.3	65.5	13.3
Sweepstakes	59.6	12.2	276.6	55.9
Eureka	43.5	8.9	7.4	1.5
Pride of the North	24.5	5.0	10.0	2.0
Early Wonder	24.5	5.0	92.2	18.6
Leaming	22.0	4.5	....	....
Big Crop	16.0	3.3	....	....
Giant Prolific	12.5	2.6	....	....
State	11.0	2.2	....	....
Golden Nugget	11.0	2.2	....	....
Iowa Gold Mine	10.0	2.0	7.0	1.4
West Branch	9.5	1.9	....	....
Illinois Flint	7.0	1.4	....	....
Golden Ensilage	6.0	1.2	9.0	1.8
Early Dent	4.0	0.8	....	....
Dibble's White	3.8	0.8	....	....
Abbott	....	....	15.3	3.1
Perfect	....	....	12.0	2.4
Kinds not found	18.0	3.7	....	....
Total	490.0	100.0	495.0	100.0

The total number of animal units per farm was 34 for the Oxford group and 34.4 for the Tully and Homer group. It will be noted that there was the same number of cows per farm in each of the areas, the latter group not raising quite so many young cattle and having one less heifer per farm (tables 22 and 24). There was one more horse per farm in the Tully and Homer group, necessitated chiefly by the cash crops raised. About the same amount of poultry was kept per farm. Since the dairies are of equal size, any difference in the financial results will be due chiefly to differences in the combination of enterprises with the dairy, or to prices received, rather than to differences in the size of the dairy business.

Of the cows on hand at the end of the year on the Oxford farms, 95 per cent were grades; and on the Tully and Homer farms, 90 per cent were grades. These were mostly of the Holstein breed.

There was practically no change in either region in the number of cows kept, but in the Tully and Homer area there was a slight increase in the proportion of purebreds. In each region about 50 more cows were purchased than were raised, showing that not enough heifers are raised to replace the cows discarded. The increased value, net sales, and value as food, of cattle, above purchases per farm, amounted to $170 for the Oxford farms and $201 for the Tully and Homer farms; so that, altho not enough cattle were raised to maintain the dairies, the increase in value of heifers and the sales of old cows and calves more than offset the purchases.

TABLE 22. APPRECIATION AND DEPRECIATION ON DAIRY CATTLE, 84 OXFORD FARMS

	Cows						Heifers											
	Grade			Purebred			Grade						Purebred					
							One year or over			Under one year			One year or over			Under one year		
	Number of forms	Number of cows	Value	Number of farms	Number of cows	Value	Number of farms	Number of heifers	Value	Number of farms	Number of heifers	Value	Number of farms	Number of heifers	Value	Number of farms	Number of heifers	Value
On hand May 1, 1921	84	1 978	$139,262	17	98	$16,405	65	272	$9,721	52	256	$4,370	10	31	$3,130	11	29	$1,520
Purchased during year	36	273	19,150	4	7	915	9	23	1,288	9	26	357	1	1	135	3	12	580
Born during year	.....	.....	.....	.....	.....	.....	.....	.....	.....	62	225	846	.....	.....	.....	11	36	1,135
Heifers that became cows	63	212	12,003	8	20	2,050	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	.....	.....	$170,415	.....	.....	$19,370	.....	.....	$11,009	.....	.....	$5,573	.....	.....	$3,265	.....	.....	$3,235
Sold	69	381.2	$ 20,927	4	21	$ 3,435	5	14	$ 584	2	8	$ 134	2	12	$1,450	3	8	$ 565
Died or killed by accident	36	57*	45	1	1	.....	3	3	.....	2	3	.....	.....	.....	.....	.....	.....	.....
Hides sold	21	40	92	.....	.....	.....	2	2	5	.....	.....	.....	.....	.....	.....	.....	.....	.....
Heifers that became cows	.....	.....	.....	.....	.....	.....	63	212	12,003	.....	.....	.....	8	20	2,050	.....	.....	.....
Used for food	22	22.8	810	.....	.....	.....	1	1	27	.....	.....	.....	.....	.....	.....	.....	.....	.....
On hand May 1, 1922	84	2,002	140,196	19	103	16,230	63	334	11,557	62	227	3,787	12	35	2,775	10	34	1,945
Total	.....	.....	$162,070	.....	.....	$19,665	.....	.....	$24,176	.....	.....	$3,921	.....	.....	$6,275	.....	.....	$2,510
Appreciation	.....						$13,800											
Depreciation	$8,050						.....											

* Including one killed by lightning, indemnity $45.

TABLE 22 (*concluded*)

	Herd bulls						Veals			Bull calves to be sold		
	Grade			Purebred								
	Number of farms	Number of bulls	Value	Number of farms	Number of bulls	Value	Number of farms	Number of veals	Value	Number of farms	Number of calves	Value
On hand May 1, 1921	35	42	$1,780	41	52.5	$4,430	......	.....	...	.....	..	.....
Purchased during year	14	14	483	9	9	318	1	2	$ 5	.....		.....
Born during year	7	7	27	3	3	12	81	1,516	4,181	5	8	$57
Heifers that became cows	.....	.....	.....	...	.....	....	....	......	.....	..		.....
Total	......	....	$2,290	.....	.....	$4,760	......	......	$4,186	...	...	$57
Sold	16	15.4	$ 740	14	14	$1,008	81† { 29 80	152.5 1,357	$1,884 3,874	2	5	$25
Died or killed by accident	....	....	....	.....	....	.....	1	6	....	......	....	.....
Hides sold	3	3	5	1	2	2	....	......	.....	....	....	...
Heifers that became cows	....	....	....	......	....	....	....	....	.....	....	.	.. ..
Used for food	3	2.6	130	2	1	40	3	2.5	40	....		....
On hand May 1, 1922	39	45	1,770	43	50.5‡	3,823	......	....	.. ..	3	3	58
Total	....	....	$2,663	......	....	$4,963	......	....	$5,798			$83
Appreciation			$576						$1,612			$26
Depreciation	....	....	....	....	....	....	....	....	....	....	....	....

† 29 farms sold 152.5 fat veals, and 80 farms sold 1357 veals at birth.
‡ One bull, a gift.

TABLE 23. SUMMARY OF LIVESTOCK OTHER THAN DAIRY CATTLE, 84 OXFORD FARMS

	Inventory at beginning of year			Purchases			Sales			Inventory at end of year			Died		Used for food		
	Number of farms	Number of head	Value	Number of farms	Number of head	Value	Number of farms	Number of head	Value	Number of farms	Number of head	Value	Number of farms	Number of head	Number of farms	Number of head	Value
Horses	84	298	$42,503	14	20	$2,370	16	21	$2,640	84	287	$39,345	8	9			
Colts	9	15	1,025	2	2	265				10	17	1,505					
Ponies	2	2	175							2	2	150					
Sheep, ewes	3	39	204				1	2	10	3	35	177	1	4			
Bucks	1	1	7							1	1	8					
Lambs, weaned							2	23	140								
Brood sows	7	12	305	2	3	90	2	1.5	43	8	11	335	1	1	4	6.5	$285
Boars	1	1	25	1	1	20				2	2	50					
Other hogs	14	31	418	8	11	98	10	17	366	8	17	193					
Pigs, weaned				4	10	52	2	13.5	78	1	3	15			22	33.5	1,023
Chickens	74	5,415	5,961	11	842	367	33	2,576	2,036	76	5,443	6,144					
Baby chicks				1	300	45											
Turkeys	7	25	132				4	29	124	6	24	122					
Ducks	6	63	84				3	75	96	7	38	56					
Geese	1	4	28							1	8	56					
Bees	2	120	702							2	123	734					
Total			$51,569			$3,307			$5,533			$48,890					$1,308

TABLE 24. APPRECIATION AND DEPRECIATION ON CATTLE, 51 TULLY AND HOMER FARMS

	Cows						Heifers											
	Grade			Purebred			Grade						Purebred					
							One year or over			Under one year			One year or over			Under one year		
	Number of farms	Number of cows	Value	Number of farms	Number of cows	Value	Number of farms	Number of heifers	Value	Number of farms	Number of heifers	Value	Number of farms	Number of heifers	Value	Number of farms	Number of heifers	Value
On hand May 1, 1921	50	1,181	$103,364	12	91	$14,475	30	150	$6,245	28	99	$2,063	6	18	$1,480	8	26	$1,510
Purchased during year	27	152	14,037	5	26	3,280	3	15	1,098				1	1	100			
Born during year										28	112	476				13	46	1,214
Heifers that became cows	29	114	8,220	6	12	1,600												
Total			$125,621			$19,355			$7,343			$2,539			$1,580			$2,754
Sold	40	282	$ 19,971	4	6	$ 790	3	8	$ 506	1	2	$ 10	1	1	$ 150	3	8	$ 208
Died or killed by accident	6	8		2	2		1	1								1	1	
Hides sold	5	7	15				1	1	3									
Heifers that became cows							29	114	8,220				6	12	1,600			
Used for food	7	7	350				1	1	50									
On hand May 1, 1922	50	1,150	100,560	16	121	18,465	31	136	5,735	29	114	2,027	10	30	2,625	13	39	2,170
Total			$120,896			$19,255			$14,514			$2,037			$4,375			$2,468
Appreciation							$9,178											
Depreciation	$4,825																	

TABLE 24 (*concluded*)

	Herd bulls						Veals			Bull calves to be sold		
	Grade			Purebred								
	Number of farms	Number of bulls	Value	Number of farms	Number of bulls	Value	Number of farms	Number of veals	Value	Number of farms	Number of calves	Value
On hand May 1, 1921	20	22	$1,225	31	30.5	$3,665	......	......	......	......	......	......
Purchased during year	5	5	218	8	8	504	......	......	......	......	......	......
Born during year	......	......	......	4	4	130	49	939	$2,692	4	17	$256
Heifers that became cows	......	......	......	......	......	......	......	......	......	......	......	......
Total	......	......	$1,443	......	......	$4,299	......	......	$2,692	......	......	$256
Sold	12	13	$607	5	5	$ 345	49* { 17 46	104 835	$1,256 } 2,446 }	3	10	$ 81
Died or killed by accident	......	......	......	1	1	......	......	......	......	......	......	......
Hides sold	1	1	4	1	0.5	2	......	......	......	......	......	......
Heifers that became cows	......	......	......	......	......	......	......	......	......	......	......	......
Used for food	2	2	110	1	0.5	25	......	......	......	......	......	......
On hand May 1, 1922	12	12	755	33	36	3,814	......	......	......	1	7	350
Total	......	......	$1,476	......	......	$4,186	......	......	$3,702	......	......	$431
Appreciation	......								$1,010			$175
Depreciation			$80				......			......		

* 17 farms sold 104 fat veals, and 46 farms sold 835 veals at birth.

TABLE 25. SUMMARY OF LIVESTOCK OTHER THAN DAIRY CATTLE, 51 TULLY AND HOMER FARMS

	Inventory at beginning of year			Purchases			Sales			Inventory at end of year			Died		Used for food		
	Number of farms	Number of head	Value	Number of farms	Number of head	Value	Number of farms	Number of head	Value	Number of farms	Number of head	Value	Number of farms	Number of head	Number of farms	Number of head	Value
Horses	51	233	$36,598	18	33	$5,050	7	10	$835	51	240	$36,586	11	17	....	.....	....
Colts	6	8	810	.....	.....	....	.....	.....	....	8	11	1,335	1	1	.....	.....	....
Sheep, ewes	1	4	48	.....	.....	....	.....	.....	....	1	4	32	.....	.....	.....	.....	....
Lambs, weaned	.....	.....	....	.....	.....	....	.....	.....	....	1	1	6	.....	.....	.....	.....	....
Brood sows	2	2	70	1	1	30	.....	.....	....	4	4	125	.....	.....	1	1	$ 29
Other hogs	11	24	271	10	24	160	3	3	79	10	19	242	2	2	20	41	1,304
Pigs, weaned	1	3	21	7	20	88	3	17	84	.....	.....	....	.....	.....	.....	.....	....
Chickens	43	2,504	3,138	3	112	150	12	631	576	43	2,714	3,378	.....	.....	.....	.....	....
Baby chicks	.....	.....	....	1	1,035	170	.....	.....	....	1	935	175	.....	.....	.....	.....	....
Guineas	1	8	8	.....	.....	....	.....	.....	....	1	8	8	.....	.....	.....	.....	....
Ducks	6	35	56	.....	.....	....	.....	.....	....	6	35	56	.....	.....	.....	.....	....
Total	.....	....	$41,020	.....	....	$5,648	.....	.....	$1,574	.....	....	$41,943	.....	.....	.....	.....	$1,333

The average amounts of feed per horse were: For the Oxford farms, concentrates, 2718 pounds; hay, 4791 pounds. For the Tully and Homer farms, concentrates, 3524 pounds; hay and other dry forage, 6216 pounds. The feeding of both hay and grain was heavier, but the pasture charge was less, in the cash-crop region. The depreciation on horses was practically double for farms with cash crops what it was for farms without them. The cost of feed and pasture per horse was $91 for the Oxford farms and $103 for the Tully and Homer farms.

The majority of the dairymen delivering at Oxford and Brisben sold their milk thru the Dairymen's League Cooperative Association, Inc. Of the Tully and Homer farmers, however, only from one-half to two-thirds participated in the pool. The number of farmers selling, the amount of milk sold wholesale, and the income received by the farmers, are given in table 26.

The average price received for pooled milk by the Oxford farmers was $2.37 per 100 pounds for 3.6-per-cent milk, comprised as follows: Grade A premiums 27 cents, certificates of indebtedness 16 cents, and cash, excluding premiums, $1.94, per 100 pounds. The average price paid by the milk buyers into the Dairymen's League Cooperative Association, Inc., for the milk from these Oxford farms, was $2.83 per 100 pounds, or 46 cents more than these farmers received. The average price received by Oxford farmers for milk pooled and milk not pooled was $2.43 per 100 pounds. A group of farmers selling milk to a condensery nine miles north of Oxford, in the same valley, received 10 cents more for their milk from the Cooperative Association than the buyers paid for it.[6] This results from the sale by the Cooperative Association of milk used for different purposes to buying concerns at different prices, and the payment of a blended price to participants in the pool. The average price received by the Tully and Homer farmers was $2.30 for 3.5-per-cent pooled milk, comprised as follows: Grade A premiums 25 cents, certificates of indebtedness 16 cents, and cash, excluding premiums, $1.89, per 100 pounds. The average price paid by the buyers at Tully and Homer to the Dairymen's League

[6] Economic studies of dairy farming in New York. I. Condensery milk without cash crops. By E. G. Misner. Cornell Univ. Agr. Exp. Sta. Bul. 421, 1923, p. 23.

Grade A deck　　　Grade B deck

FIGURE 11. COUNTRY PLANT AT OXFORD, NEW YORK, EQU

Cooperative Association, Inc., for the milk from these farms, was $2.77 per 100 pounds, or 47 cents more than these farmers received. The average price received by Tully and Homer farmers for milk pooled and milk not pooled was $2.62 per 100 pounds.

When considering these prices, due recognition must be made of the fact that one company in this last group did not pay Grade A premiums for two months of the year, and that the prices are the result of dividing the total dollars by the total pounds. Difference in the distribution of production therefore also affects the average price.

The monthly distribution of milk production on the farms in the two areas is shown in table 27. This may be compared with the seasonal distribution of the freshening of cows shown in table 68. On the Oxford farms a larger proportion of the milk was produced from March to July than on the Tully and Homer farms. This is probably due in part to the facts that a larger proportion of the land is pastured, and that practically no cash crops are grown in the Oxford area. Heavy milking in spring and summer to some extent delays and interferes with crop work, and a shortage of pasture favors winter dairying. On the Oxford farms the production and income from milk during the pasture and winter periods were about equal; but on the Tully and Homer farms the production was more than one-half larger, and the income from the milk was nearly three-fourths larger, in winter than in the pasture period. The loss of the premium due to milk of high bacteria count is greater in the summer months, and the premium is less in April, May, and June. Therefore, Grade A dairymen who tend to produce a much larger amount of milk during summer than in winter operate at a disadvantage in these respects.

The farms included represent over one-half of the supply of these plants. The monthly distribution of the production of all milk for which Grade A premiums were paid at Oxford and Brisben, given in table 27, is the same as for the farms studied, thus substantiating their representativeness.

The base prices, in addition to the Grade A premiums paid for milk by the three companies, and the pool prices paid by the Dairymen's League

ANDLING GRADE A AND GRADE B MILK SEPARATELY

TABLE 26. RETURNS FROM MILK SOLD WHOLESALE, 135 FARMS

Month	Milk pooled *: Farms selling	Milk sold wholesale (pounds)	Fat in milk sold wholesale (pounds)	Average butterfat (per cent)	Amount dealer paid excluding Grade A premiums	Grade A premiums	Amount received by farmers for milk: Certificates of indebtedness	Cash	Total	Total per 100 pounds	Milk not pooled: Farms selling	Milk sold wholesale (pounds)	Fat in milk sold wholesale (pounds)	Average butterfat (per cent)	Amount dealer paid for milk excluding Grade A premiums	Grade A premiums	Total	Total per 100 pounds
	Oxford farms																	
1921:																		
May (pasture)	...	715,669	25,219	...	$15,537	$1,443	$ 712	$14,273	$14,985	...	...	165,097	5,775	...	$3,545	$296	$3,841	...
May (winter)	...	402,024	14,350	...	8,838	796	398	8,022	8,420	...	...	102,362	3,634	...	2,222	192	2,414	...
May (total)	67	1,117,693	39,569	3.5	24,375	2,239	1,110	22,295	23 405	$2 09	17	267,459	9,409	3 5	5,767	488	6,255	$2 34
June	69	1,044,289	37,109	3 6	20,118	1,886	1,044	17,698	18,742	1.79	15	218,645	7,675	3.5	4,174	336	4,510	2 06
July	69	792,165	28,747	3 6	18,037	1,944	792	16,308	17,100	2 16	15	166,774	5,957	3 6	3,759	361	4,123	2 47
August	69	787,140	29,297	3 7	22,975	2,298	1,568	19,613	21,181	2 69	15	163,029	5,847	3.6	4,666	415	5,081	3 12
September	71	693,851	26,175	3 8	21,121	1,921	1,388	18,031	19,419	2.80	13	123,272	4,434	3 6	3,665	343	4,008	3.25
October (pasture)	...	586,586	22,573	...	19,929	1,903	1,173	17,118	18,291	...	...	93,033	3,504	...	3,129	314	3,443	...
October (winter)	...	92,445	3,634	...	3,173	313	185	2,729	2,914	...	...	16,922	626	...	566	68	634	...
November (pas're)	...	10,824	422	...	350	38	21	316	337	...	...	...	...	...	...	...	...	...
November (winter)	...	575,183	21,694	...	18,260	1,902	1,150	16,367	17,517	...	...	79,693	2,951	...	2,510	290	2,800	...
October (total)	72	679,031	26,207	3.9	23,102	2,216	1,358	19,817	21,205	3 12	12	109,955	4,130	3 8	3,695	382	4,077	3 71
November (total)	73	586,007	22,116	3 8	18,610	1,940	1,171	16,683	17,854	3 05	11	79,693	2,951	3.7	2,510	290	2,800	3.51
December	73	666,305	24,338	3 7	20,539	2,352	1,332	18,712	20,044	3 01	11	88,222	3,117	3 5	2,682	344	3,026	3.43
1922:																		
January	74	716,812	25,629	3 6	21,215	2,397	1,431	17,595	19,029	2 65	10	77,352	2,735	3.5	2,277	305	2,582	3 34
February	73	735,498	25,289	3 4	20,492	2,488	1,471	16,707	18,178	2.47	10	79,888	2,682	3 4	2,198	294	2,492	3.12
March	74	961,514	32,847	3.4	20,834	3,008	1,923	17,795	19,718	2 05	10	103,908	3,392	3 3	2,188	363	2,551	2.46
April	84	1,106,949	37,098	3 4	21,924	2,260	1,112	17,233	18,345	1 66	...	...	...	...	...	...	...	...
Total:																		
Pasture	...	4,630,524	169,542	3 7	$118,067	$11,433	$ 6,698	$103,357	$110,055	$2.38	..	929,850	33,192	3.6	$22,938	$2,068	$25,006	$2.69
Winter	...	5,256,730	184,879	3.5	135,275	15,516	9 005	115,160	124,165	2 36	...	548,347	19,137	3.5	14,643	1,856	16,499	3 01
Year	...	9,887,254	354,421	3.6	253,342	26,949	15,703	218,517	234,220	2 37	...	1,478,197	52,329	3 5	37,581	3,924	41,505	2 81

TABLE 26 (*concluded*)

Month	Milk pooled *						Amount received by farmers for milk				Milk not pooled							
	Farms selling	Milk sold wholesale (pounds)	Fat in milk sold wholesale (pounds)	Average butterfat (per cent)	Amount dealer paid excluding Grade A premiums	Grade A premiums	Certificates of indebtedness	Cash	Total	Total per 100 pounds	Farms selling	Milk sold wholesale (pounds)	Fat in milk sold wholesale (pounds)	Average butterfat (per cent)	Amount dealer paid excluding Grade A premiums	Grade A premiums	Total	Total per 100 pounds
	Tully and Homer farms																	
1921:																		
May (pasture)	....	189,936	6,617	....	$4,126	$ 138	$190	$3,496	$3,686	....	....	222,959	7,749	....	$ 4,990	$ 224	$ 5,211	..
May (winter)	....	237,181	8,427	....	5,173	141	237	4,298	4,535	....	......	197,583	6,851	....	4,406	231	4,637	....
May (total)	29	427,117	15,044	3.5	9,299	279	427	7,794	8,221	$1.92	24	420,542	14,600	3.5	9,396	455	9,851	$2.34
June	29	382,843	13,324	3.5	7,068	179	383	5,776	6,159	1.61	24	362,504	12,444	3.4	6,779	412	7,191	1.98
July	29	282,182	10,038	3.6	6,301	724	283	5,733	6,016	2.13	24	281,594	9,700	3.4	6,202	549	6,751	2.40
August	29	243,279	8,886	3.7	7,185	473	487	5,723	6,210	2.55	24	264,893	9,169	3.5	7,705	517	8,222	3.10
September	30	207,258	7,705	3.7	6,336	538	414	5,250	5,664	2.73	23	278,290	9,701	3.5	8,328	584	8,912	3.20
October (pasture)	......	118,388	4,413	....	4,082	390	237	3,355	3,592	....	......	183,279	6,401	....	6,235	563	6,798	......
October (winter)	....	107,638	4,025	....	3,704	368	215	3,077	3,292	....	.....	138,122	4,836	....	4,714	442	5,156	......
October (total)	30	226,026	8,438	3.7	7,786	758	452	6,432	6,884	3.05	23	321,401	11,237	3.5	10,949	1,005	11,951	3.72
November	30	221,407	7,972	3.6	6,391	711	443	6,076	6,519	2.94	23	311,321	10,893	3.5	9,997	1,095	11,092	3.56
December	29	246,434	8,683	3.5	7,700	891	493	6,743	7,236	2.94	24	353,515	12,612	3.6	11,641	1,379	13,020	3.68
1922:																		
January	31	291,163	10,177	3.5	8,399	1,140	582	7,111	7,693	2.64	21	372,709	12,824	3.4	11,259	1,415	12,674	3.40
February	33	297,847	10,131	3.4	7,972	1,162	596	6,755	7,351	2.47	20	346,197	11,945	3.5	9,904	1,238	11,142	3.22
March	32	367,464	12,578	3.4	7,819	1,455	735	7,025	7,760	2.11	22	428,995	14,717	3.4	9,588	1,508	11,096	2.59
April	28	329,424	11,345	3.4	6,563	539	329	4,961	5,290	1.61	24	467,161	16,036	3.4	8,332	1,061	9,393	2.01
Total:																		
Pasture	....	1,423,886	50,983	3.6	$35,098	$2,442	$1,994	$29,333	$31,327	$2.20	....	1,593,519	55,164	3.5	$ 40,239	$ 2,849	$ 43,088	$2.70
Winter	.....	2,098,558	73,338	3.5	53,721	6,407	3,630	46,046	49,676	2.37	......	2,615,603	90,714	3.5	69,841	8,369	78,210	2.99
Year	......	3,522,444	124,321	3.5	88,819	8,849	5,624	75,379	81,003	2.30	......	4,209,122	145,878	3.5	110,080	11,218	121,298	2.88

* Milk pooled is that sold thru the Dairymen's League Cooperative Association, Inc. This milk entered into the League pool, and the producers received the net pool price. The "Amount dealer paid excluding Grade A premiums" and the "Grade A premiums" together represent the money which Borden's, Clover Farms, and Sheffield Farms paid to the Cooperative Association for milk delivered to them by members of the association, or paid directly to the farmers for milk delivered by producers not affiliated with the Cooperative Association.

TABLE 27. DISTRIBUTION OF MILK PRODUCTION

	84 Oxford farms							51 Tully and Homer farms						
	Total pounds of milk sold wholesale	Per cent	Per cent of distribution of production of all milk for which Grade A premiums were paid at Oxford and Brisben*	Butterfat test of milk (per cent)	Value per farm including certificates of indebtedness but excluding Grade A premiums	Grade A premiums per farm	Total per farm	Total pounds of milk sold wholesale	Per cent	Per cent of distribution of production of all milk for which Grade A premiums were paid at Homer†	Butterfat test of milk (per cent)	Value per farm, including certificates of indebtedness but excluding Grade A premiums	Grade A premiums per farm	Total per farm
1921:														
May	1,385,152	12.2	11.9	3.5	$321	$32	$353	847,659	11.0	7.8	3.5	$340	$14	$354
June	1,262,934	11.1	10.7	3.5	251	26	277	745,347	9.6	8.1	3.5	250	12	262
July	958,939	8.4	8.3	3.6	225	28	253	563,776	7.3	4.2	3.5	225	25	250
August	950,169	8.4	8.0	3.7	280	32	312	508,172	6.6	7.2	3.6	263	20	283
September	817,123	7.2	7.4	3.7	252	27	279	485,548	6.3	5.2	3.6	264	22	286
October	788,986	6.9	6.8	3.8	270	31	301	547,427	7.1	6.9	3.6	335	35	370
November	665,700	5.9	5.8	3.8	219	27	246	532,728	6.9	8.1	3.5	310	35	345
December	754,527	6.6	6.7	3.6	243	32	275	599,949	7.7	9.6	3.5	352	45	397
1922:														
January	794,164	7.0	7.2	3.6	225	32	257	663,872	8.6	10.9	3.5	349	50	399
February	815,386	7.2	7.2	3.4	213	33	246	644,044	8.3	10.0	3.4	316	47	363
March	1,065,422	9.4	9.6	3.4	225	40	265	796,459	10.3	11.6	3.4	312	58	370
April	1,106,949	9.7	10.4	3.4	191	27	218	796,585	10.3	10.4	3.4	256	31	287
Total	11,365,451	100.0	100.0	3.6	$2,915	$367	$3,282	7,731,566	100.0	100.0	3.5	$3,572	$394	$3,966
Total pasture	5,560,374	48.9	....	3.6	$1,447	$161	$1,608	3,017,405	39.0	....	3.5	$1,355	$104	$1,459
Total winter	5,805,077	51.1	....	3.5	$1,468	$206	$1,674	4,714,161	61.0	....	3.5	$2,217	$290	$2,507

* These figures are furnished thru the courtesy of the Borden's Farm Products Company.
† These figures are furnished thru the courtesy of the Clover Farms, Inc.

Cooperative Association, Inc., are shown in table 28. The difference between the prices paid by these concerns varied from practically nothing in July to $1.065 in November. All of this milk was produced for the New York market. The drivers' strike in New York City may have been blamable to some extent for the large difference in the November prices.

TABLE 28. COMPARISON OF MONTHLY POOL PRICES RECEIVED BY FARMERS' AND PRICES PAID BY MILK BUYERS, FOR MILK PER 100 POUNDS

(3-per-cent fat basis, excluding low-count premiums)

	Pool prices, including certificate of indebtedness			Prices paid by buyers		
	Oxford and Brisben	Tully	Homer	Borden's Farm Products Co., at Oxford and Brisben	Sheffield Farms Co., at Tully	Clover Farms, Inc., at Homer
1921:						
May	$1.675	$1.655	$1.655	$1.95	$1.90	$2.12
June	1.390	1.370	1.370	1.705	1.63	1.73
July	1.670	1.645	1.650	2.025	2.015	2.03
August	2.120	2.095	2.100	2.63	2.685	2.74
September	2.210	2.185	2.190	2.735	2.765	2.81
October	2.440	2.415	2.420	3.06	3.115	3.24
November	2.401	2.386	2.389	2.865	2.195	3.26
December	2.378	2.365	2.368	2.825	2.75	3.17
1922:						
January	2.080	2.055	2.060	2.73	2.565	2.89
February	1.940	1.915	1.920	2.61	2.38	2.76
March	1.570	1.545	1.550	2.00	1.865	2.145
		(Apulia)	(Dryden)			
April	1.305	1.280	1.230	1.84	1.695*	1.59*
Simple yearly average	$1.932	$1.909	$1.908	$2.41	$2.30	$2.54

* These two companies did not purchase milk thru the Dairymen's League Cooperative Association, Inc., during April.

A comparison of the simple yearly average prices, including certificates of indebtedness, paid to poolers by the Dairymen's League Cooperative Association, Inc., in the various locations studied, with the prices paid by the buyers to non-poolers and to the Cooperative Association for milk, indicates that the buyers' prices averaged at Norwich 12.3 cents less, at Oxford and Brisben, 47.8 cents more, at Tully, 39.1 cents more, and at Homer, 63.2 cents more, than the average pool prices (table 29).

In the month of April, 1922, the Sheffield Farms Company and the Clover Farms, Inc., refused to purchase milk through the Dairymen's League Cooperative Association, Inc. The April milk of Tully producers who sold thru the Cooperative Association was sent to Apulia and that of the Homer producers to Dryden. The pool prices given for that month, therefore, apply to those two places, instead of where the milk was sold during the remainder of the year. The full Grade A premium was paid

TABLE 29. COMPARISON OF SIMPLE YEARLY AVERAGES ON 3-PER-CENT FAT BASIS, EXCLUDING PREMIUMS

	Simple average of pool prices, including certificates	Simple yearly average of prices buyers paid for milk to non-poolers and to the Cooperative Association	Difference between price paid by buyers and pool price
Norwich (condensery producers)	$1.939	$1.816	$0.123 less
Oxford and Brisben (Grade A producers)	1.932	2.410	0.478 more
Tully (Grade A producers)	1.909	2.300	0.391 more
Homer (Grade A producers)	1.908	2.540	0.632 more

at Dryden if the count was low enough, for there was a Grade A plant at that place operated by a company that purchased through the Cooperative Association. It was difficult to keep the count down because the milk was trucked about fourteen miles. At Apulia there was no Grade A station, but the Cooperative Association paid the producers 15 cents per 100 pounds in April in place of a Grade A premium as a compensation for lack of an opportunity to get a premium.

In addition to the pool prices given above, 1.32 cents per 100 pounds[7] was returned to poolers on December 13, 1922, to cover unpaid amounts from May 1, 1921, to March 31, 1922.

Some of the reasons why the pool prices received for milk sold thru the Cooperative Association were lower than the average prices paid by the companies are:

1. The milk was sold to the buyers at different prices for several different uses, such as for city distribution, for condensing, and for butter, cheese, and cream.

2. The milk buyers included in this study were concerns that used as fluid milk a larger proportion of milk than the average.

3. The expenses for conducting the Cooperative Association were deducted before returns were made to farmers. These expenses included advertising, organization, administration, and other operating expenditures.

4. The year studied was the first year of any extensive operation of plants by the Cooperative Association in order to provide a market for its members' milk. It would be expected that the operation of such plants would not be as economical at first as it would be after the business had become well established.

The premium for low-count milk amounted to $367 per farm, or 6 per cent on $6117 per farm, for the Oxford group, and $394, or 6 per cent on $6567 per farm, for the Tully and Homer groups. While the premium amounts to interest on over $6000 per farm, buyers could not afford to pay this much more for a farm with such a special marketing opportunity,

[7] All gain or loss results in this bulletin should be corrected by this amount. It was not known what he amount would be when the records were summarized.

because of the additional cost of producing this grade of milk. Nevertheless, this additional source of income should make the average value of these farms from $2000 to $4000 higher than the value of farms so situated that they cannot realize it.

If full premiums had been received for all milk sold, excluding the milk sold to Sheffield Farms at Tully during May and June before that Company

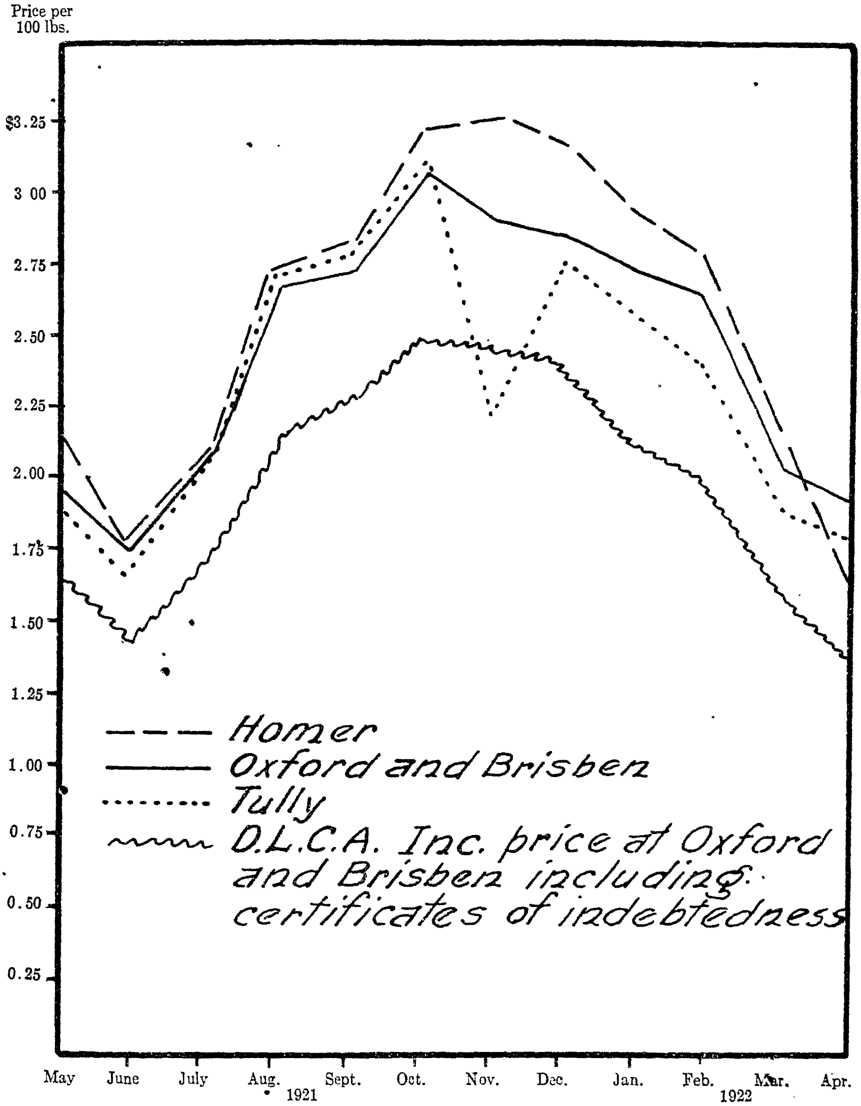

FIGURE 12. PRICES PER 100 POUNDS OF MILK (ON 3-PER-CENT FAT BASIS) RECEIVED BY FARMERS IN POOL AT OXFORD AND BRISBEN, AND PRICES PAID BY THREE COMPANIES TO NON-POOLERS AND TO THE DAIRYMEN'S LEAGUE COOPERATIVE ASSOCIATION, INC.

began the handling of Grade A milk there, the amount would have been \$474 per farm for the Oxford farms and \$498 per farm for the Tully and Homer farms. Thus the actual premiums received were, for the year, 77.5 and 79.1 per cent, respectively, of the maximum amount possible to receive on the production obtained with the rate of premium paid. This varied, however, with different months according to variations in temperature and other conditions which make it difficult to keep the count down. In both areas the largest percentage of the maximum amount of premium possible was obtained in December, January, and February, and the smallest percentage in July, August, and September. In the Tully and Homer group a slightly larger proportion of the possible premium was obtained in winter and a lower proportion was obtained in summer than for the Oxford farms. For the year, however, there was practically no difference in the percentage of the possible premium obtained in the two areas. (Table 30).

TABLE 30. COMPARISON OF MAXIMUM PREMIUMS POSSIBLE, AND PREMIUMS ACTUALLY RECEIVED, ON GRADE A FARMS

	Oxford farms			Tully and Homer farms		
	Maximum low-count premium	Amount actually received	Per cent actually received	Maximum low-count premium	Amount actually received	Per cent actually received
1921:						
May	\$3,463	\$2,727	78.7	\$1,078	\$ 734	68.1
June	3,157	2,222	70.4	948	591	62.3
July	3,836	2,308	60.2	2,255	1,273	56.5
August	3,801	2,713	71.4	2,033	990	48.7
September	3,268	2,264	69.3	1,942	1,122	57.8
October	3,156	2,598	82.3	2,190	1,763	80.5
November	2,663	2,230	83.7	2,131	1,806	84.7
December	3,018	2,696	89.3	2,400	2,270	94.6
1922:						
January	3,177	2,702	85.0	2,655	2,555	96.2
February	3,262	2,782	85.3	2,576	2,400	93.2
March	4,262	3,371	79.1	3,186	2,963	93.0
April	2,767	2,260	81.7	1,991	1,600	80.4
Total	\$39,830	\$30,873	77.5	\$25,385	\$20,067	79.1

When the premium is based on the monthly average, samples are taken once a week instead of twice a week. The disadvantage of this method is that a very high count for one week may necessitate the loss of the premium on the entire four weeks production. In the warm months of April to October a much lower percentage of the possible maximum premiums is obtained by farmers at Tully and Homer, where a weekly count is made, than at Oxford, where twice-a-week counts are made. In the cold winter months of November to March, the opposite is true. While the results for the entire year are about the same with the distribution of production prevailing on the farms studied, if the same distribution of production prevailed on the Oxford farms as on the others, and the proportion of maximum premiums obtained each month remained as it

was for the Oxford farms, the average for the year would favor the Oxford plan by 7 per cent.

The certificates of indebtedness amounted to $21,327 for all of the farms. This represents money of which the farmer had no use during the year under study. Certificates indicating the obligation of the Co-operative Association, bearing 6 per cent interest from May 1, 1923, and a promise to pay the principal amount to the farmers within five years, were received during the summer of 1923.

The milk companies very courteously allowed their records of bacteria counts for the individual producers to be studied. This permitted a study of the counts under hand and machine milking and by months for all farms, and the average count for morning and afternoon milk for the Oxford producers.

For the Oxford farms the average monthly count for milk by hand milking was little more than one-half that by machines, but the difference was less from October to December than in other months of the year (table 31). The highest average counts were in July and September. July is the hottest month, and ice frequently gets short in September.

TABLE 31. AVERAGE BACTERIA COUNT (COLONIES PER CUBIC CENTIMETER) OF MILK, OXFORD AND BRISBEN DAIRIES

	Machine milking				Hand milking			
	Number of farms	Average count: Morning milk	Average count: Afternoon milk	Monthly average	Number of farms	Average count: Morning milk	Average count: Afternoon milk	Monthly average
1921:								
May	31	13,500	18,100	15,800	48	8,000	9,800	8,900
June	31	12,200	20,100	16,200	48	9,700	11,300	10,500
July	31	24,400	29,100	26,800	48	13,200	16,900	15,100
August	28	15,700	22,600	19,200	49	9,100	15,300	12,200
September	27	19,300	33,100	26,200	53	13,000	17,800	15,500
October	22	10,100	8,600	9,300	58	12,000	10,600	11,300
November	20	9,000	12,100	10,600	60	9,500	7,200	8,400
December	22	7,800	8,900	8,300	61	4,500	5,300	4,900
1922:								
January	18	19,200	24,500	21,800	65	3,800	4,900	4,400
February	20	17,500	23,100	20,300	62	5,400	6,100	5,700
March	23	16,200	23,800	20,000	60	7,300	6,200	6,700
April	27	14,900	13,900	14,300	57	10,700	7,500	9,100
Simple average	....	14,983	19,825	17,400	....	8,850	9,908	9,392

The average count of all Oxford dairies was below 10,000 in seven months of the year with hand milking, and in two months of the year with machine milking. The average count with machine milking is increased by occasional very high counts.

With hand milking, the morning count averaged lowest in eight months of the year, the exceptions being October, November, March, and April; with machine milking, the morning count was lowest ten months of the

FIGURE 13. KEEPING THE MILK AT A LOW TEMPERATURE, AN ESSENTIAL IN INSURING A LOW BACTERIA COUNT

year, the exceptions being October and April. For the year, the afternoon milk averaged 32 per cent higher than the morning milk with machine milking and 12 per cent higher with hand milking. The chief reason why the night's milk shows a higher count than the morning's milk is that the time between milking and sampling is longer, and therefore the bacteria have had greater opportunity to multiply.

Altho the counts averaged over 10,000 for milk, this does not necessarily indicate that the average count for all the milk was as high as this Also, the average is very much less than the count allowed by the City Health Department after pasteurization.

Quality rests in the article itself. The lower the bacteria count, usually the cleaner the milk. The premiums now paid are about as small as can be to assure the extra attention from farmers that is needed to keep the count down. With the price level that prevails for other commodities and wages, and the losses farmers are now experiencing, any lower premiums for low-count milk will result in less attention being given to methods of production.

It is impossible for a dairyman to keep all conditions about his premises, and his methods of milk production, above trifling criticism at all times, and still make a living. Some inspectors from the city have not spent enough time near a farm to become acquainted with this fact. The result is that sometimes premises are declared in an unsatisfactory condition for ridiculous reasons, while some more serious situation is overlooked. Such mistakes always antagonize the producer, encourage disrespect for the system, and seldom improve the quality of the milk supply.

TABLE 32. FREQUENCY OF OBTAINING AND LOSING PREMIUMS IN OXFORD AND BRISBEN DAIRIES, SHOWN BY THE NUMBER OF FARMS RECEIVING FULL, PART, OR NO PREMIUMS FOR THE NUMBER OF WEEKS INDICATED

	Machine milking												Hand milking											
	Full premium				Part premium				No premium				Full premium				Part premium				No premium			
	Weeks				Weeks				Weeks				Weeks				Weeks				Weeks			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1921:																								
May	3	6	9	8	10	5	1	3	3	2	2	0	3	7	14	21	14	6	1	0	3	4	0	1
June	8	11	4	4	10	9	4	2	11	0	2	0	8	6	12	18	11	10	3	0	5	1	1	2
July	9	7	1	1	4	12	6	2	7	4	4	3	3	12	12	11	16	12	4	0	8	4	2	2
August	4	6	5	10	7	6	0	1	4	2	1	2	7	7	17	13	19	7	5	1	9	2	0	2
September	6	5	6	2	9	7	3	1	5	5	1	3	4	9	18	17	17	11	1	1	8	7	0	0
October	0	6	4	12	7	1	0	0	5	1	0	0	2	7	18	31	18	2	0	0	8	2	1	0
November	3	1	6	8	7	1	2	1	1	0	1	0	0	8	21	31	23	3	0	0	4	2	0	0
December	2	1	8	9	6	2	0	2	2	1	0	0	1	5	11	43	8	5	1	0	3	0	0	0
1922:																								
January	1	4	3	6	7	2	0	0	3	3	2	1	0	4	11	49	8	3	0	0	3	1	0	0
February	1	7	3	5	4	7	1	0	4	2	1	1	1	3	15	42	10	2	2	0	7	0	0	0
March	1	4	5	6	4	4	3	0	3	4	0	3	4	5	14	36	15	7	0	0	7	2	0	0
April	6	5	6	6	13	4	2	1	7	3	2	0	2	1	19	32	12	2	0	1	11	0	0	2

A certain farmer who had missed only one full bacteria premium in eighteen months was rated as unsatisfactory by a city inspector. Yet his three bacteria counts for the month previous to the date of inspection averaged 1333 and were lower than those of 129 other patrons out of 197 delivering to the company. When his milk was accepted the next month after reinspection, the count was again lower than the majority of the patrons. This cost the farmer exactly $56.34, because the inspector questioned the cleanliness of his milking machine while he was producing cleaner milk than most of the dairymen. While his milk with a count of less than 2000 was being refused, milk from 17 patrons with counts of 20,000 to 2,000,000, was going in the Grade A supply. The inspector would have performed better public service by turning his attention to producers who had been running the

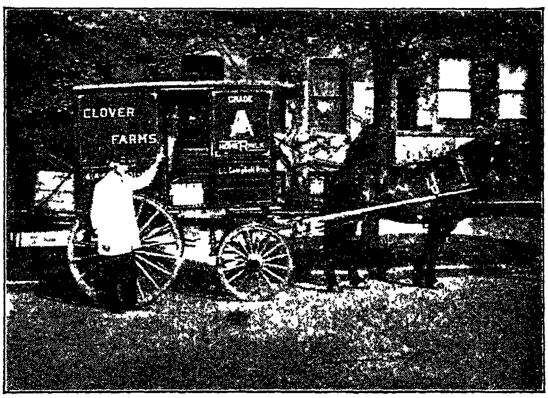

FIGURE 14. SERVICE ADVERTISING, THE MOST EFFECTIVE WAY OF INCREASING CONSUMPTION OF A HIGH-GRADE PRODUCT

high counts. Inspectors would benefit the consumers more by watching the counts of producers, and then cooperating with those with high counts to help them improve their methods, than by trying to catch farmers on minor points of the score card. In general, farmers are always very willing to cooperate in improving a method whereby a high quality of milk can be maintained.

When a milking machine is used, the most important precautions to observe with respect to the use of the machine in order to obtain a low bacteria count are:

1. Draw a cold-water rinse thru the machines after each milking. Repeat with boiling water.

2. Take the machines completely apart once each week, cleaning and scalding all parts thoroly.

3. Keep the cups and tubes in a brine solution when not used. Renew this solution frequently.

4. Draw some milk before placing the cups on the teats to determine whether there is any garget, or inflammation of the udder. Keep all such milk out of the cans.

The possibility of obtaining low-count milk is not the most important consideration in deciding whether or not a milking machine is an economical piece of equipment for the dairy farm, but rather its influence on the organization of the farm. If the system of farming necessitates keeping enough men for other work who could also do the milking by hand, then the use of a milking machine increases the cost. Furthermore, a milker ordinarily lessens the chance of securing the premiums. Usually, enough more milking can be accomplished with a milker to pay all the costs of operating the milker; and even tho a greater loss of premiums may occur, the use of the milker will still be more economical and much easier than hand milking.

Some of the essentials to observe in the production of low-count milk, listed not necessarily in the order of their importance, are:

1. A clean barn free from dust, particularly stirring dust.
2. Clean cows, particularly the udders.
3. Clean utensils.
4. Discarding of milk from animals with infected udders. The very high counts are usually traceable to infected quarters.
5. Quick, continuous, and complete cooling.
6. Transportation without delay.

The location of the milk house has much to do with the cooling of the product. A milk house situated so that there is no running thru it and that it does not get the afternoon sun, maintains a lower evening temperature. A wooden trough saves ice. If well water is available, much ice can often be saved, and the milk more quickly cooled, by pumping the well water into the vat. The pump may be hitched to the milking-machine engine. Promptness is essential in cooling milk; the night's milk cannot be cooled in the morning and be expected to have a low count.

On the 84 Oxford farms the following makes of milkers were found: Empire, 14; Universal, 22; Hinman, 3; Pine Tree, 2; B. L. K., 1; a total of 42 machines. These were purchased as follows: in 1913, 1; in 1916, 3; in 1918, 8; in 1919, 9; in 1920, 13; in 1921, 6; in 1922, 2. Of these machines

TABLE 33. MISCELLANEOUS RECEIPTS, 135 FARMS

	84 Oxford farms.					51 Tully and Homer farms				
	Amount	Price	Value			Amount	Price	Value		
			Farm	Operator	Landlord			Farm	Operator	Landlord
Human labor off farm	355.5 days	$ 5.01	$ 1,782	$ 1,782	......	226 days	$ 3.27	$ 738	$ 738	......
Horse labor off farm	304 days	2.49	756	756	......	306 days	2.02	617	617	......
Use of machinery	197 days	4.75	935	635	$300	52.7 days	....	625*	625	......
Use of pasture	......	....	163	163	......	......	....	208	128	$ 80
Maple sirup	482 gallons	2.02	974	929	45	1736 gallons	1.96	3,401	2,101	1,300
Maple sugar	660 pounds	0.25	166	166	......	......	....	......	......	......
Honey	5690 pounds	0.20	1,110	1,110	......	......	....	......	......	......
Lumber	55.5 thousand feet	28.65	1,590	1,590	......	7.9 thousand feet	34.30	271	271	......
Wood	270 cords	2.94	795	795	......	191 cords	1.64	314	314	......
Telephone poles	82	2.00	164	164	......	......	....	......	......	......
Ties	125	1.14	142	142	......	......	....	......	......	......
Eggs	31,065 dozen	0.36	11,156	10,621	535	8441 dozen	0.35	2,976	2,961	15
Ducks' eggs	20	0.30	6	6	......	......	....	......	......	......
Baby chicks	1714	0.15	254	254	....	......	....	......	......	......
Wool	750 pounds	0.40	300	300	......	35 pounds	0.20	7	7	......
Feed bags	6402	0.04	249	235	14	4534	0.04	172	157	15
Hauling milk	......	....	845	662	183	......	....	......	......	......
Premiums at fair	......	....	1	1	......	......	....	......	......	......
Hides	133	1.22	162	140	22	15	1.73	26	26	......
Indemnity for cows killed by lightning	1	45.00	45	45	......	......	....	......	......	......
Board of cattle	......	....	22	22	......	......	....	......	......	......
Breeding fees	......	....	79	79	......	......	....	......	......	......
Sand and gravel	......	....	......	......	......	......	....	2,000	....	2,000
Land rented out	......	....	......	......	......	......	....	360	360	......
Total	......	....	$21,696	$20,597	$1,099	......	....	$11,715	$8,305	$3,410

* Including $120 for machinery for which no days are given.

the following were not used at any time during the year: Empire bought in 1919, 1; Universals bought in 1919, 1, in 1920, 2; Pine Tree bought in 1920, 1; a total of 5. The remaining 37 were used as follows: in January, 18; in February, 20; in March, 23; in April, 27; in May, 32; in June, 32; in July, 32; in August, 31; in September, 29; in October, 24; in November, 22; in December, 22; making a total of 312 months out of 444, or 70.3 per cent of the time. The summer dairies used their milkers 82 months out of 156, or 53 per cent of the time; the middle group, 131 out of 168, or 78 per cent of the time; and the winter dairies, 99 months out of 120, or 82 per cent of the time. The 37 milkers now used were bought as follows: in 1913, one Hinman; in 1916, two Empires, one Hinman; in 1918, four Empires, one Pine Tree, three Universals; in 1919, one B. L. K., three Empires, three Universals; in 1920, six Universals, three Empires, one Hinman; in 1921, one Empire, five Universals; in 1922, two Universals.

Of the 84 farms, 14 used trucks, the distribution of the different makes being as follows: Ford 8, International 2, Nash 1, Republic 1, Sampson 1, Stewart 1. Seven farms had tractors of the following makes: Case 1, Fordson 3, International 2, Waterloo Boy 1.

On the 51 Tully and Homer farms there were twenty-two milking machines, purchased as follows: in 1915, one Empire, one Hinman, one Sharples; in 1916, one Sharples; in 1917, one Sharples, one Universal; in 1918, one Empire, two Hinmans, one Sharples; in 1919, two Empires, one New Way, one Sharples, one Universal; in 1920, one Empire, one Hinman, one New Way, one Pine Tree, one Sharples; in 1921, one Universal; in 1922, one Empire; making a total of six Empires, four Hinmans, two New Way, one Pine Tree, six Sharples, and three Universals.

Of the twenty-two milking machines on the 51 Tully and Homer farms, 19 were used during the year as follows: in January, 15; in February, 15; in March, 15; in April, 16; in May, 18; in June, 18; in July, 16; in August, 14; in September, 15; in October, 12; in November, 12; in December, 14; making a total of 180, or 79 per cent of the time.

Of the 51 farms, 9 used trucks as follows: Atterby 1, Ford 7, Reo Speed Wagon 1. Eleven farms had tractors of the following makes. Fordson 8, International 1, Case 1, Waterloo Boy 1.

The mechanical milker saves more labor, and is a more efficient piece of equipment for most dairy farms, than the tractor.

The miscellaneous receipts were chiefly for eggs, labor off the farms, lumber and wood, maple products, and honey, on the Oxford farms; and for eggs, maple sirup, sand, gravel, and labor off the farm, for the Tully and Homer group (table 33).

FARM EXPENSES

The current operating expenses per farm were $2828 for the Oxford group, of which 28.1 per cent was for labor, 34.2 per cent was for cattle and horse feed, 6.4 per cent was for taxes, and 31.3 per cent was for other items (table 34). The expense for new buildings averaged $66, and the purchase of livestock $316, per farm, so that the total farm expenses for the Oxford farms were $3210 per farm.

The operating expenses for the Tully and Homer farms averaged $3997 per farm, of which 32.3 per cent was for labor, 25.9 per cent was for cattle

TABLE 34. EXPENSES ON 135 FARMS

	84 Oxford farms			51 Tully and Homer farms		
	Value			Value		
	Total	Per farm	Per cent	Total	Per farm	Per cent
Labor, hired	$36,443	$434	15.4	$33,976	$ 666	16.7
Labor, unpaid	19,184	228	8.1	21,809	428	10.7
Board of hired labor	10,887	130	4.6	9,979	196	4.9
Rent of house for hired man	96	1	0.0	......	......	......
Advertising	9	......	......	......	......	......
Bedding	332	4	0.1	453	9	0.2
Baling	144	2	0.1	100	2	0.0
Barrels, baskets, bags, cases	274	3	0.1	204	4	0.1
Breeding fees	134	2	0.1	108	2	0.0
Building repairs, roofing, paints	7,525	90	3.2	7,604	149	3.7
Salt	898	11	0.4	851	17	0.4
Poultry, hog, and sheep feed	6,004	71	2.5	1,640	32	0.8
Pasturage	710	9	0.3	737	14	0.4
Commissions	22	......	......	100	2	0.0
Freight, expressage	66	1	0.0	404	8	0.2
Drains	92	1	0.0	108	2	0.0
Hay, silage, stalks, straw	2,437	29	1.0	1,886	37	0.9
Cattle and horse feed	81,192	967	34.2	52,675	1,033	25.9
Feed grinding	270	3	0.1	445	9	0.2
Feed hauling	18	......	......	......	......	......
Fence, wire, posts, staples	1,381	16	0.6	1,273	25	0.6
Fertilizer	2,298	27	1.0	8,863	174	4.4
Lime	1,701	20	0.7	1,968	39	1.0
Manure	80	1	0.0	......	......	......
Horse shoeing	3,620	43	1.5	3,395	66	1.7
Insurance	2,159	26	0.9	1,839	36	0.9
Lumber sawing	259	3	0.1	1,077	21	0.5
New machinery	9,333	111	3 9	8,494	166	4.2
Repairs on machinery	4,064	48	1.7	3,644	71	1.8
Machines hired	292	4	0.1	359	7	0.2
Filling silo	1,740	21	0.7	2,450	48	1.2
Threshing	428	5	0.2	1,681	33	0.8
Coal, oil, gasoline, for farm use	3,171	38	1.3	2,993	59	1.5
Twine	529	6	0.2	780	15	0.4
Farm share of upkeep and operation of automobile	5,895	70	2.5	4,987	98	2.5
Ice and sawdust for ice	868	10	0.4	847	17	0.4
Hauling milk	3,772	45	1.6	3,311	65	1.6
Milk bottles, cans, strainers	2,182	26	0.9	1,232	24	0.6
Cow tester, acid, fees, etc.	148	2	0.1	......	......	......
Registration fees	93	1	0.0	104	2	0.0
Seed, grass	2,513	30	1.1	3,666	72	1.8
Other seeds, plants, trees	2,025	24	0.9	2,964	58	1.5
Spray materials	204	2	0.1	671	13	0.3
Sirup cans	11	......	......	9	......	......
Sap buckets	......	......	......	20	......	......
Carbide	124	2	0.1	35	1	0.0
Dairymen's League deductions	42	1	0.0	60	1	0.0
Water system	355	4	0.1	......	......	......
Hydrated lime	19	......	......	37	1	0.0
Lights	373	4	0.1	78	2	0.0

TABLE 34. EXPENSES ON 135 FARMS (*concluded*)

	84 Oxford farms			51 Tully and Homer farms		
	Value			Value		
	Total	Per farm	Per cent	Total	Per farm	Per cent
Stamps, stationery, for farm use	$ 101	$ 1	0.0	$ 48	$ 1	0.0
Telephone and toll, farm use	675	8	0.3	1,133	22	0.6
Taxes, including school tax	15,088	180	6.4	9,420	185	4.7
Veterinary, medicine, etc.	1,341	16	0.6	1,334	26	0.7
Any other farm expenses	3,948	47	1.7	2,017	39	1.0
Total (except new buildings and cash rent)	$237,569	$2,828	100.0	$203,868	$3,997	100.0
Cash rent	2,050	......	......	2,240	......	......
New buildings	5,539	66	......	25,900	508	......
Total	$245,158	......	......	$232,008	......	......
Operator	$230,238	......	......	$210,120	......	......
Landlord	14,920	......	......	21,888	......	......
Total	$245,158	......	......	$232,008	......	......
Livestock purchased:						
Operator	$24,498	......	......	$20,483	......	......
Landlord	2,040	......	......	4,402	......	......
Total	$26,538	$316	......	$24,885	$488	......

and horse feed, 4.7 per cent was for taxes, and 37.1 per cent was for other items. The expense for new buildings and improvements to buildings averaged $508 per farm and the expense for livestock purchased was $488 per farm, so that the total farm expenses amounted to $4993 per farm.

Some criticism is occasionally made of the use of automobiles in the country. The farmer living a considerable distance from his market has more need for rapid transportation than do persons in many other kinds of business. The expense, however, of maintaining the automobile for the part of the work which is considered farm labor was less than $100 per farm, or only 2.5 per cent of the total farm expense.

The increase in the value of real estate per farm for the Tully and Homer region, allowed for building and other improvements, was $556.

LABOR INCOMES

The returns a farmer receives for his year's labor and management constitute his labor income. This income represents the amount of money left after paying all the business expenses of the farm and deducting interest on the money invested in the farm business; and is an addition to the use of a dwelling and the products furnished by the farm toward the family living.

The difference between the total farm receipts and the total farm expenses was $951 for the Oxford farms. Interest at 5 per cent on the

$13,040 capital was $652, which when deducted from $951 leaves an average labor income on the 84 farms of $299.

The difference between the farm receipts and the farm expenses for the Tully and Homer farms was $2025. Interest at 5 per cent on the $19,204 capital was $960, which when deducted from $2025 results in an average labor income on the 51 farms of $1065.

The summary of the receipts, expenses, interest, and labor income for three areas of this survey as they were found, and as they stand recalculated on the assumption that all farmers had received for their milk the pool prices that prevailed, is given in table 35. This comparison is made to eliminate the differences due to a larger proportion of farmers in one

TABLE 35. LABOR INCOMES IN THREE AREAS AS FOUND, AND AS COMPUTED ASSUMING THAT ALL MILK HAD BEEN SOLD AT PREVAILING DAIRYMEN'S LEAGUE COOPERATIVE ASSOCIATION, INC., POOL PRICES

	83 condensery farms (Norwich)		84 Grade A farms (Oxford and Brisben)		51 Grade A farms (Tully and Homer)	
	As found	At pool prices	As found	At pool prices	As found	At pool prices
Farm receipts:						
Milk:						
Cash	$2,397	$2,371	$3,102	$2,998	$3,856	$3,258
Certificates of indebtedness	147	200	187	214	110	245
All else	613	613	872	872	3,052	3,052
Total	$3,157	$3,184	$4,161	$4,084	$7,018	$6,555
Farm expenses*	$2,688	$2,688	$3,210	$3,210	$4,993	$4,993
Farm income	469	496	951	874	2,025	1,562
Interest at 5 per cent	647	647	652	652	960	960
Labor income†	- 178	- 151	+ 299	+ 222	+ 1,065	+ 602
If Grade A premiums are deducted	-$178	-$151	-$68	-$145	+$671	+$208

* No charge made for operator's time.
† That is, amount by which farm income is more or less than interest.

of the regions not selling thru the Cooperative Association. It should be recognized, however, that if all of the milk had been sold thru the Cooperative Association, the pool prices would probably have been slightly higher. If all milk had been sold at pool prices, the average labor income for the 84 Oxford farms would have been $77 less, or $222; that of the 51 Tully and Homer farms, $463 less, or $602; and that of the 83 Norwich condensery farms mentioned above, $27 more, or minus $151.

When all the labor incomes are placed on a pool-price basis, a comparison of them made in the different areas with the different systems of farming is more nearly, altho not precisely, accurate.

The difference in the organization of the farms between the condensery producers at Norwich and the Grade A producers at Oxford and Brisben was chiefly in slightly more intensive farming and the receipt of premiums by the Grade A producers. If the Grade A premiums were deducted

from the labor income and pool prices used, the Oxford farmers would lack about the same amount of making interest as did the Norwich farmers. The Tully and Homer farmers would still make a labor income of $208, but this figure is less than $400 more than any of the other groups, and their cash-crop sales were about $1600 more. The apparent reasons for the reward to the farmer not being correspondingly greater with the additional income on the Tully and Homer farms are that the labor expense was about $500 more per farm, the fertilizer expense about $150 more, the seed and many other expenses higher, and the interest about $300 more because of the higher values of land and livestock.

With milk prices the same, if the farmers had received directly in cash all of the money paid by the dealers for milk, the average labor income would have been $548 more for the Oxford farms, or $847. After a year's allowance of $826 is made for the operator's time, the return on the capital would then have been 5 per cent. But if the Tully and Homer farmers had received pool prices for milk, without premiums, and 6 per cent on their capital, they would then have received practically no cash labor income ($16) even with the exceptionally high prices for and large sales of potatoes and cabbage. So it must be realized that the chief circumstances which saved them from losing money as did the Norwich dairymen reported in Cornell Experiment Station Bulletin 421, were that many received better than pool prices, that they had the premiums for low bacteria count in milk, and that their income was increased by sales of crops.

This comparison is not entirely correct, because if more of these farmers had received pool prices for their milk the degree of intensiveness of farming would have been considerably lessened, thereby reducing expenses as well as incomes.

The labor income per farm ranged from minus $2495 to plus $3449 on the Oxford farms, and from minus $2087 to plus $4871 on the Tully and Homer farms. There were 42 farms that failed to make interest, and 36 farms that made labor incomes of over $1000. The variation in the labor income is shown in table 36. Of the Oxford farms, 14 made

TABLE 36. VARIATION IN LABOR INCOMES ON 84 OXFORD AND 51 TULLY AND HOMER FARMS

	Minus $500 or more (number)	Minus $499 to 0 (number)	Plus 1 to plus $500 (number)	Plus $501 to $1000 (number)	Over $1000 (number)
Oxford:					
Per cent of cows freshening from September to December inclusive:					
Less than 25	8	8	9	9	3
From 25 to 50	5	2	7	6	10
More than 50	2	1	6	7	1
Total Oxford	15	11	22	22	14
Tully and Homer:					
Tully	9	3	5	6	6
Homer	1	3	....	2	16
Total Tully and Homer	10	6	5	8	22

labor incomes of over $1000 and 26 failed to make interest. Of the Tully and Homer farms, 22 made labor incomes of over $1000 and 16 failed to make interest. As many farmers fail to make interest as succeed in the making of $1000, or more for their time, above interest and that part of the family living expenses which they get from the farms. This fact holds true for all survey work done on New York farms.

The milk receipts ranged from $994 cash and $74 in certificates of indebtedness, a total of $1068, to $8694 cash and $648 in certificates of indebtedness, a total of $9342, for the Oxford farms. On the Tully and Homer farms, they ranged from $1017 cash plus $67 in certificates of indebtedness, a total of $1084, to $13,289 cash.

The returns from a farm business may be expressed in terms of interest earned on the capital by deducting from the farm income the value placed by the operator on his time. This value was $826 for the Oxford group and $1170 for the Tully and Homer group. There are then left earnings of $125 per farm, or about 1 per cent on the capital, for the Oxford group, and $855 or 4.5 per cent, for the other group, above the value of the operators' time.

The total capital on the Tully and Homer farms was $6164 per farm, or 47 per cent higher than it was for the Oxford group. If the labor income should increase in proportion to the capital in the business, then, with pool prices and capital equal to the other group, the Oxford farmer should make an average labor income of $326 per farm. The other group would make $602 on the same basis.

The results here reported are from farms having more capital, larger business, more favorable location, better soil, and many other advantages not enjoyed by numerous farms in the regions. Some of the very best farms and the most skillful operators were included. If all the farms in the regions were included in the survey, the returns per man engaged in the business would be less than for those reported here.

Persons govern their spending habits according to their wages. Farmers receiving higher wages because either the year has been favorable or the system has paid, have better homes and spend more for living. This fact is illustrated by the relation of dairying systems to the standard of living in three areas (table 37.)

The average cash living costs for the 84 Oxford operators' families were $357 for food, $145 for clothes, and $170 for other expenses, a total of $672 per farm, or $56 a month; for the 51 Tully and Homer families, the costs were $480 for food, $248 for clothes, and $276 for other expenses, totaling $1004 per farm, or $84 a month; for the Norwich farms, the costs were $312 for food, $116 for clothing, and $130 for all other living expenses, totaling $558 per farm, or $47 per month.

When the variation in the farmer's estimate of the value of his own time is considered, the results show that those who placed the highest value on their time received the lowest labor incomes. This value in no way influences the labor income, but it does influence the cost of the milk.

The Oxford farmers who valued their time at over $1000, had, on an average, 37 per cent more cows, altho the cows were not any better,

TABLE 37. RELATION OF SYSTEM OF DAIRYING TO STANDARD OF LIVING

	System of dairying		
	Condensery farms, Norwich	Grade A farms without cash crops, Oxford	Grade A farms with cash crops, Tully and Homer
Number of farms	83	84	51
Labor income as found	-$178	+$299	+$1,065
Labor income on pool-price basis	-$151	+$222	+$602
Value of operator's dwelling	$1,505	$1,476	$2,016
Cash expenditures for:			
Food	$312	$357	$480
Clothing	116	145	248
All other living costs	130	170	276
Total cash expenditures for living	$558	$672	$1,004

and 50 per cent more capital, than those who valued their time at less than $700. The difference in labor incomes between these two groups was $536. Similar differences are shown for the Tully and Homer farms (table 38). There may be a tendency for the more successful operators to put a modest value on their time, but the chief reason is that those who valued their time most operated a more extensive business, and the year of the survey was not so favorable as others have been for the large business.

TABLE 38. RELATION OF VALUE OF OPERATOR'S TIME TO VARIOUS FACTORS

Value of operator's time	Number of farms	Average acres per farm	Average capital per farm	Number of cows per farm	Hundredweight of milk produced per cow	Cost of milk per hundredweight sold wholesale	Average labor income	Average value of operator's time
	84 Oxford farms							
Less than $700	23	167	$10,878	21.5	58.6	$2.40	+$446	$ 580
From $700 to $1000	47	204	13,112	25.2	56.0	2.63	+342	829
Over $1000	14	204	16,352	29.4	59.2	2.72	-90	1,219
	51 Tully and Homer farms							
Less than $700	3	267	$31,367	42.7	59.5	$2.42	+$1,525	$ 600
From $700 to $1000	18	145	15,976	20.4	63.7	2.61	+1,266	861
Over $1000	30	172	19,924	26.0	63.8	2.94	+955	1,412

COSTS AND RETURNS IN PRODUCING MILK

The costs in producing milk have been classified as follows: concentrates, succulent feed, dry forage, pasture, bedding, labor, hauling milk, use of buildings, use of equipment, interest, depreciation on cows, bull service, and miscellaneous charges. The returns are for milk and milk products, calves born during the year, manure, and miscellaneous returns.

COSTS

Concentrates

The average value of home-grown grain was $34.98 per ton, and of purchased concentrates $37.56 per ton, for the Oxford farms (table 39), and $33.07 and $38.60 per ton, respectively, for the Tully and Homer farms (table 40). Of the feed used by cows in the winter period on the Oxford farms, 97.2 per cent was purchased, and on the Tully and Homer farms 91.4 per cent was purchased. Of the grain and concentrates used by horses on the Oxford farms, 62.5 per cent was purchased, and on the other farms 15.3 per cent was purchased. The tendency in the Tully and Homer region was to use concentrates with a higher percentage of protein than those used in the Oxford region had.

The charge for concentrates in producing milk was $33.45 per cow on the Oxford farms and $40.59 per cow on the Tully and Homer farms. This was 62 cents and 67 cents, respectively, per 100 pounds of milk sold.

Succulent feed

The average values per ton for silage were $6.25 for the Oxford farms (table 41) and $5.24 for the Tully and Homer farms (table 42). In the Oxford area a considerable amount of corn and some millet was fed green. In the other areas some peavines and alfalfa were fed green. Most of the alfalfa so used was of the second cutting. In the Tully and Homer region a large amount of cabbage refuse was harvested and fed. The average value of this was $4.15 per ton. The expense of growing root crops is so great compared with the cost of energy in silage that practically none are grown.

Ensilage can be kept for summer use by sealing the surface with horse manure. If moistened and tramped, horse manure is better than chaff, straw, or sawdust for excluding air. Very few farms have small silos for summer feeding, and so, since many of the cows with a winter system are dry when the supplementary feed is needed, the most effective use of held-over ensilage is sometimes not made.

It has often been suggested that enough silage be grown to allow for summer feeding when pastures are short, but the majority of winter dairymen use hay for this purpose. The explanation is simple; energy can be acquired more cheaply in hay than in silage, and cows that are dry during July and August need energy chiefly, more than they need succulent feed. Unless by giving silage in addition to pasture to furnish energy for dry cows, more business can be done so that the additional income exceeds the additional expense, hay is the most economical barn roughage feed for dry cows in summer just as it is in winter. On most winter dairy farms, the use of more of the pasture land to increase the hay acreage, or the purchase of more land on which to grow hay, would pay better than to grow silage for summer feeding. If the land carries enough lime to grow alfalfa, the advantage of using hay is still greater.

While hay is the cheapest source of energy and therefore provides the maintenance of a cow at less expense than does silage, the use of silage supplementary to pasture serves as the balance wheel of production for the farmer who operates a year-round dairy. Cows that have access

TABLE 39. CONCENTRATES USED BY 2088 COWS, 609 HEIFERS, 95 HERD BULLS, AND 292 HORSES, ON 84 OXFORD FARMS

Kind of feed	Total			Cows				Heifers		Bulls		Horses	
				Pasture period		Winter period							
	Amount (cwt.)	Average price per ton	Value	Amount (cwt.)	Value	Amount (cwt.)	Value	Amount (cwt.)	Value	Amount (cwt.)	Value	Amount (cwt.)	Value
Home-grown:													
Corn for grain	851	$32.20	$1,370	......	......	332	$522	45	$ 71	6	$ 9	468	$ 768
Corn for grain, surplus silage	608	29.90	909	......	......	126	214	102	131	16	23	364	541
Oats	2,366	37.01	4,378	......	......	280	541	158	295	16	28	1,912	3,514
Oats, 1920	242	36.28	439	......	......	......	......	16	26	......	......	226	413
Buckwheat	98	40.00	196	......	......	91	178	......	......	......	......	7	18
Winter wheat	20	28.00	28	......	......	20	28	......	......	......	......	......	......
Total home-grown	4,185	$34.98	$7,320	......	......	849	$1,483	321	$523	38	$60	2,977	$5,254
Purchased:													
Cornmeal	2,737	$31.64	$ 4,330	233	$ 373	2,137	$ 3,385	143	$223	58	$ 95	166	$ 254
Hominy	432	32.59	764	43	69	251	404	52	90	9	15	77	126
Corn and oats	6,124	34.01	10,415	317	551	2,494	4,254	336	574	110	188	2,867	4,848
Cracked corn	40	33.00	66	......	......	......	......	......	......	......	......	40	66
Whole corn	233	32.02	373	......	......	......	......	13	20	7	10	213	343
Whole oats	960	38.77	1,861	......	......	......	......	......	......	......	......	960	1,861
Ground oats	1,601	34.62	2,771	102	175	840	1,439	99	164	34	58	526	935
Ground barley	278	32.59	453	73	118	197	324	6	8	2	3	......	......
Molasses	133	34.44	229	28	45	105	184	......	......	......	......	......	......
Wheat bran	3,037	33.85	5,140	240	384	2,424	4,122	224	385	54	91	95	158
Wheat middlings	496	34.23	849	127	200	335	590	28	50	6	9	......	......
Wheat feed	4,112	33.76	6,941	710	1,118	3,226	5,532	143	233	33	58	......	......
Rye middlings	355	28.79	511	113	156	237	348	3	4	2	3	......	......
Gluten feed	13,665	40.24	27,496	3,323	6,643	9,964	20,081	262	537	116	235	......	......
Gluten meal	119	50.08	298	36	90	75	188	6	15	2	5	......	......
Cottonseed meal	562	49.43	1,389	62	150	483	1,198	11	26	6	15	......	......
Oilmeal	1,396	50.96	3,557	81	207	1,182	3,011	94	241	24	64	15	34
Palmo middlings	378	22.70	429	35	44	332	373	7	8	4	4	......	......
Coconut meal	113	26.02	147	40	52	68	89	5	6	......	......	......	......
Calf meal	23	64.35	74	......	......	......	......	23	74	......	......	......	......
Schumacher	20	28.00	28	......	......	......	......	20	28	......	......	......	......
Arcady Dairy Feed	2,935	40.67	5,969	462	1,067	2,286	4,547	129	237	58	118	......	......
Cloverleaf Dairy Feed	227	37.18	422	126	240	99	178	......	......	2	4	......	......
Comet	246	36.02	443	......	......	237	427	......	......	9	16	......	......
G. L. F. Dairy Feed	462	43.12	996	92	184	361	794	6	12	3	6	......	......
The H. O. Company's New England Stock Feed	222	37.84	420	27	43	192	372	2	3	1	2	......	......
The H. O. Company's Read the Tag	127	42.99	273	......	......	124	267	......	......	3	6	......	......
The H. O. Company's Milk Feed with Molasses	93	40.65	189	53	105	25	56	15	28	......	......	......	......

Jumbo Stock Feed	36	46.67	84	......	......	......	......	36	84	......	......	......	......
More Milk Ready Ration Dairy Feed	280	35.64	499	81	144	171	305	15	27	13	23	......	......
Red Brand Tioga Dairy Feed	190	36.53	347	......	......	180	324	10	23	......	......	......	......
Riverdale Dairy Ration	684	45.38	1,552	168	383	495	1,122	16	36	5	11	......	......
Sucrene Dairy Feed	300	35.00	525	......	......	300	525	......	......	......	......	......	......
Distillers' dried grains	610	46.00	1,403	180	414	418	961	8	19	4	9	......	......
Dairy feed (kinds not found)	4	45.00	9	......	......	4	9	......	......	......	......	......	......
Total purchased	43,230	$37.56	$81,192	6,752	$12,955	29,242	$55,409	1,712	$3,155	565	$1,048	4,959	$8,625
Total concentrates	47,415	$37.33	$88,512	6,752	$12,955	30,091	$56,892	2,033	$3,678	603	$1,108	7,936	$13,879

TABLE 40. CONCENTRATES USED BY 1274 COWS, 306 HEIFERS, 50 HERD BULLS, AND 236 HORSES ON 51 TULLY AND HOMER FARMS

Kind of feed	Total			Cows				Heifers		Bulls		Horses	
				Pasture period		Winter period							
	Amount (cwt.)	Average price per ton	Value	Amount (cwt.)	Value	Amount (cwt.)	Value	Amount (cwt.)	Value	Amount (cwt.)	Value	Amount (cwt.)	Value
Home-grown:													
Corn for grain	456	$ 30.13	$ 687	......	......	35	$ 57	17	$ 15	......	......	404	$ 615
Corn for grain, surplus silage	28	32.14	45	......	......	......	......	......	......	......	......	28	45
Oats	4,834	32.68	7,899	72	$122	560	893	166	290	29	$49	4,007	6,545
Oats, 1920	522	34.87	910	......	......	......	......	......	......	......	......	522	910
Oats and barley	2,224	33.29	3,702	30	70	518	826	12	24	23	42	1,641	2,740
Oats and barley, 1920	104	29.23	152	......	......	......	......	......	......	......	......	104	152
Oats, wheat, and barley	496	37.42	928	30	75	182	354	......	......	15	24	269	475
Oats, wheat, and barley, 1920	200	27.60	276	160	221	......	......	......	......	......	......	40	55
Oats, peas, and barley	306	33.07	506	......	......	271	447	30	51	5	8	......	......
Barley	108	33.15	179	......	......	47	75	33	54	8	13	20	37
Buckwheat	147	34.01	250	......	......	130	221	1	2	6	10	10	17
Winter wheat	135	37.48	253	......	......	96	189	39	64	......	......	......	......
Rye and vetch	6	100.00	30	......	......	......	......	6	30	......	......	......	......
Total home-grown	9,566	$33.07	$15,817	292	$488	1,839	$3,062	304	$530	86	$146	7,045	$11,591
Purchased:													
Cornmeal	2,074	$31.56	$ 3,273	335	$ 514	1,173	$ 1,849	175	$276	48	$ 76	343	$558
Hominy	326	34.85	568	3	6	288	506	31	50	4	6	......	......
Corn and oats	328	34.51	566	......	......	45	79	......	......	......	......	283	487
Cracked corn	53	22.26	59	......	......	......	......	......	......	......	......	53	59
Ground oats	883	35.18	1,553	18	32	397	716	71	127	25	43	372	635
Molasses	20	32.00	32	......	......	20	32	......	......	......	......	......	......
Wheat bran	2,165	30.36	3,286	656	997	1,447	2,184	47	81	15	24	......	......
Wheat middlings	31	36.13	56	10	18	6	11	15	27	......	......	......	......
Wheat feed	4,984	32.39	8,072	1,214	1,948	3,194	5,212	277	448	84	136	215	328
Teco flour	54	24.81	67	......	......	49	61	5	6	......	......	......	......
Buckwheat middlings	262	20.23	265	......	......	254	257	6	6	2	2	......	......
Gluten feed	8,157	38.35	15,643	1,966	3,664	5,969	11,544	150	296	72	139	......	......
Cottonseed meal	404	56.78	1,147	39	113	359	1,017	4	11	2	6	......	......
Oilmeal	2,344	54.54	6,392	409	1,092	1,769	4,846	129	350	32	90	5	14
Beet pulp	62	38.06	118	......	......	52	99	8	15	2	4	......	......
Calf meal	5	88.00	22	......	......	......	......	5	22	......	......	......	......
Cornell Ration	152	38.03	389	38	72	108	205	2	4	4	8	......	......
Farmer's Syndicate Feed	3,486	45.00	7,843	332	748	3,109	6,992	32	72	13	31	......	......
Purina Cow Chow	110	48.00	264	......	......	110	264	......	......	......	......	......	......
Red Brand Tioga Dairy Feed	250	46.00	575	80	184	170	391	......	......	......	......	......	......
Sucrene Dairy Feed	681	34.16	1,163	151	256	503	860	19	32	8	15	......	......
Brewers' dried grains	281	64.98	913	......	......	280	910	......	......	1	3	......	......
Distillers' dried grains	184	55.33	509	2	6	176	486	5	14	1	3	......	......
Total purchased	27,296	$38.60	$52,675	5,253	$9,650	19,478	$38,521	981	$1,837	313	$586	1,271	$2,081
Total concentrates	36,862	$37.16	$68,492	5,545	$10,138	21,317	$41,583	1,285	$2,367	399	$732	8,316	$13,672

TABLE 41. SUCCULENT FEED USED BY 2088 COWS, 609 HEIFERS, AND 95 HERD BULLS, ON 84 OXFORD FARMS

Kind of feed	Total			Cows				Heifers		Bulls	
				Pasture period		Winter period					
	Amount (tons)	Average price per ton	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value
Home-grown:											
Corn silage	6,141	$ 6.25	$38,368	139	$ 869	5,540.7	$34,632	373.7	$2,331	87.6	$536
Corn silage, 1920	142	6.61	939	116	777	26	162	......	......	....	....
Oat silage	13	4.00	52	......	......	11.5	46	1.5	6	....	....
Oat and pea silage	28	6.25	175	......	......	28	175	......	......	....	....
Corn, green	281	4.73	1,329	280.5	1,327	......	......	0.5	2	....	....
Sweet corn	20	4.00	80	20	80	......	......	......	......	....	....
Potatoes	8.4	9.52	80	......	......	7.8	71	0.6	9	......	....
Cabbage refuse	2	5.00	10	2	10	......	......	......	......	....	....
Rowen, green	4	8.00	32	4	32	......	......	......	......	....	....
Millet	68	4.03	274	68	274	......	......	......	......	....	....
Mangels	5	25.00	125	......	......	5	125	......	......	....	....
Oats and peas	11	10.00	110	11	110	......	......	......	......	....	....
Buckwheat	14.5	3.52	51	14.5	51	......	......	......	......	....	....
Hay, green	3	12.00	36	3	36	......	......	......	......	....	....
Total home-grown	6,740.9	$6.18	$41,661	658.0	$3,566	5,619.0	$35,211	376.3	$2,348	87.6	$536
Purchased:											
Skimmilk	0.27	$18.52	$ 5	......	......	......	......	0.27	$5	....	....
Corn silage	7	2.86	20	......	......	7	$20	......	......	....	....
Total purchased	7.27	$3.44	$25	......	......	7	$20	0.27	$5	....	....
Total succulent feed	6,748.17	$6.18	$41,686	6580.0	$3,566	5,626.0	$35,231	376.57	$2,353	87.6	$536
Total succulent feed except skimmilk	6,747.9	$6.18	$41,681	6580.0	$3,566	5,626.0	$35,231	376.3	$2,348	87.6	$536

TABLE 42. SUCCULENT FEED USED BY 1274 COWS, 306 HEIFERS, AND 50 HERD BULLS, ON 51 TULLY AND HOMER FARMS

Kind of feed	Total			Cows: Pasture period		Cows: Winter period		Heifers		Bulls	
	Amount (tons)	Average price per ton	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value
Home-grown:											
Corn silage*	6,059	$ 5.24	$31,744	95.0	$ 498	5,142	$26,942	619.5	$3,245	201.5	$1,054
Corn silage, 1920	482	5.25	2,529	467.0	2,450	15	79	......	......	......	......
Millet silage	19	5.00	95	......	......	16	80	3	15	......	......
Peavine silage	22	3.00	66	......	......	20	60	2	6	......	......
Corn, green	180	5.49	988	180.0	988	......	......	......	......	......	......
Sweet corn	10	5.00	50	10.0	50	......	......	......	......	......	......
Potatoes	5.5	19.45	107	......	......	5.5	107	......	......	......	......
Cabbage refuse	110	4.15	456	100.0	406	10	50	......	......	......	......
Rowen, green	32	5.84	187	32.0	187	......	......	......	......	......	......
Millet	73	5.40	394	73.0	394	......	......	......	......	......	......
Oats and peas	30.5	5.34	163	30.5	163	......	......	......	......	......	......
Buckwheat	12	5.00	60	12.0	60	......	......	......	......	......	......
Pea refuse	66	3.61	238	14.0	40	48	184	2	6	2	8
Alfalfa, first cutting	8	6.00	48	8.0	48	......	......	......	......	......	......
Alfalfa, second cutting	66	8.47	559	66.0	559	......	......	......	......	......	......
Alfalfa, third cutting	16	7.00	112	16.0	112	......	......	......	......	......	......
Hay, green	3	10.00	30	3.0	30	......	......	......	......	......	......
Total home-grown*	7,194.0	$5.26	$37,826	1,106.5	$5,985	5,256.5	$27,502	626.5	$3,272	203.5	$1,062
Purchased:											
Corn silage	66	$2.85	$188	......	......	52	$146	12	$36	2	$6
Pea silage	24	2.58	62	......	......	24	62	......	......	......	......
Total purchased	90	$2.78	$250	......	......	76	$208	12	$36	2	$6
Total succulent feed*	7,284.0	$5.23	$38,076	1,106.5	$5,985	5,332.5	$27,710	638.5	$3,308	205.5	$1,068

* One ton of silage, valued at $5, was fed the horses.

to abundant pasture at the beginning of the lactation period will produce heavier when silage is used in conjunction with pasture than when hay is used. Not enough facts were obtained in this study to indicate whether it is decidedly profitable to have liberal quantities of silage to use supplementary to pasture when a large proportion of the cows freshen during June, July, and August.

The charge for succulent feed averaged $18.58 per cow on the Oxford farms and $26.45 per cow on the Tully and Homer farms, or 34 and 44 cents, respectively, per 100 pounds of milk sold.

Dry forage

The average value of all hay per ton was $16.40 for the Oxford farms (table 43) and $14.51 for the Tully and Homer farms (table 44). In the first group the hay was mostly mixed hay other than clover, or timothy hay, but no alfalfa was used. On the latter farms, however, about twice as much clover and alfalfa as other hay was used for cows. Horses received mostly timothy with some other mixed hay. On the Oxford farms the purchases of hay exceeded the sales, but on the Tully and Homer farms a surplus was sold.

The charge for dry forage averaged $34.94 per cow for the Oxford farms and $24.55 per cow for the Tully and Homer farms, or 64 and 40 cents, respectively, per 100 pounds of milk sold.

Quantities of feed used

The average pounds of feed used per cow for the year on Oxford farms were: concentrates, 1765; succulent feed, 6019; dry forage, 4433. On the Tully and Homer farms the average pounds were: concentrates, 2108; succulent feed, 10,109; and dry forage, 3540. (Table 45.) The pasture season was 168 days for the former farms and 154 days for the latter; the acreage of pasture per cow was, 3.6 acres for the Oxford farms and 2.8 acres for the Tully and Homer group.

The amount of grain and ensilage used was greater in the Tully and Homer area. More hay was used in the Oxford region. In the vicinity of Tully, where the acreage was smaller and the tendency toward the raising of crops was greater, less grain was used than in any of the areas studied.

Protein and energy used

In the analysis of feeding practices in relation to the economy of production, the quantities of protein and energy contained in the feed is of more importance than the quantities of the different feeds. The total amount and derivation of the protein and the energy in the feed used supplementary to pasture and in the winter feed, is shown in table 47. The amounts used per cow per day in the winter period compared with the same data for other areas are given in table 48. The derivation of protein and energy, and the protein-energy ratio for the farms under report and for other regions studied by the writer, are given in table 49.

A broad comparison between the Oxford and the Tully and Homer regions indicates that there was no difference, on the average, in the energy intake per cow. Between regions this generally holds true. The protein

TABLE 43. DRY FORAGE USED BY 2088 COWS, 609 HEIFERS, 95 HERD BULLS, AND 292 HORSES, ON 84 OXFORD FARMS

Kind of feed	Total			Cows				Heifers		Bulls		Horses	
				Pasture period		Winter period							
	Amount (tons)	Average price per ton	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value
Home-grown:													
Alfalfa, first, cutting	8	$16.25	$ 130	......	......	7	$ 113	1	$ 17	......	......	......	......
Alfalfa, second, cutting	2	15.00	30	......	......	2	30	......	......	......	......	......	......
Mixed hay (clover)	1,085.5	16.85	18,288	......	......	974.5	16,282	79.5	1,469	13	$ 230	18.5	$ 307
Mixed hay (other)	2,727	16.29	44,421	11	$199	1,871.2	30,685	371.8	5,746	120.5	1,998	352.5	5,793
Rowen	72	16.64	1,198	......	......	69	1,147	3	51	......	......	......	......
Timothy	1,055	17.16	18,102	......	......	677.8	11,589	78.2	1,433	33	551	266	4,529
Oat hay	232	13.80	3,202	......	......	174.5	2,483	17	170	......	......	40.5	549
Oat and pea hay	97.5	18.95	1,848	......	......	92.5	1,764	3	48	......	......	2	36
Millet	15	14.40	216	......	......	15	216	......	......	......	......	......	......
Hay, 1920	250.5	14.01	3,509	......	......	245.5	3,434	2	30	......	......	3	45
Total hay	5,544.5	$16.40	$90,944	11	$199	4,129.0	$67,743	555.5	$8,964	166.5	$2,779	682.5	$11,259
Oat straw	8	$8.75	$ 70	......	......	2.5	$ 15	3	$30	......	......	2.5	$ 25
Corn stover	131	6.18	809	......	......	125	759	5.5	45	0.5	$ 5	......	......
Corn for the silo (surplus fodder)	103	9.07	934	13	$78	79	641	6	35	......	......	5	180
Corn fodder	161	8.90	1,433	......	......	157	1,398	2	15	2	20	......	......
Total straw, stover, etc.	403	$8.05	$3,246	13	$78	363.5	$2,813	16.5	$125	2.5	$25	7.5	$205
Total home-grown	5,947.5	$15.84	$94,190	24	$277	4,492.5	$70,556	572.0	$9,089	169.0	$2,804	690.0	$11,464
Purchased:													
Alfalfa	10	$20.00	$ 200	......	......	10	$ 200	......	......	......	......	......	......
Mixed hay	123.3	17.86	2,202	......	......	101.8	1,924	11	$97	2	$40	8.5	$141
Timothy	1	15.00	15	......	......	......	......	......	......	......	......	1	15
Total purchased	134.3	$18.00	$2,417	......	......	111.8	$2,124	11	$97	2	$40	9.5	$156
Total dry forage	6,081.8	$15.88	$96,607	24	$277	4,604.3	$72,680	583.0	$9,186	171.0	$2,844	699.5	$11,620

TABLE 44. DRY FORAGE USED BY 1274 COWS, 306 HEIFERS, 50 HERD BULLS, AND 236 HORSES, ON 51 TULLY AND HOMER FARMS

Kind of feed	Total			Cows				Heifers		Bulls		Horses	
				Pasture period		Winter period							
	Amount (tons)	Average price per ton	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value
Home-grown:													
Alfalfa, first, cutting	530	$14.44	$ 7,653	13	$ 165	406.3	$5,950	15	$ 178	15.7	$ 205	80	$1,155
Alfalfa, second, cutting	219	17.26	3,780	74	1,371	125.6	2,069	17.9	318	1.5	22	......	......
Alfalfa, third, cutting	28	17.32	485	3	60	11	205	12	190	2	30	......	......
Mixed hay (clover)	689	14.02	9,657	16	240	531.2	7,527	65.8	887	21	272	55	731
Mixed hay (other)	407	13.31	5,419	......	......	210.5	2,874	41.5	543	11	144	144	1,858
Rowen	42	13.76	578	16	170	26	408	......	......	......	......	......	......
Timothy	936	14.89	13,936	2	34	386.5	5,992	80	1,158	43.5	632	424	6,120
Oat hay	37	10.00	370	13	130	15	150	9	90	......	......	......	......
Oat and pea hay	2	10.00	20	......	......	2	20	......	......	......	......	......	......
Millet	20	14.60	292	......	......	20	292	......	......	......	......	......	......
Alfalfa, 1920	9	15.56	140	......	......	5	72	......	......	......	......	4	68
Timothy, 1920	4	13.00	52	......	......	......	......	......	......	......	......	4	52
Hay, 1920	86.5	14.89	1,288	3	45	66	1,002	1	15	......	......	16.5	226
Total hay	3,009.5	$14.51	$43,670	140	$2,215	1,805.1	$26,561	242.2	$3,379	94.7	$1,305	727.5	$10,210
Oat straw	4	$6.75	$ 27	......	......	3	$ 21	1	$ 6	......	......	......	......
Corn stover	71	2.65	188	......	......	57	157	12	27	2	$ 4	......	......
Corn for the silo (surplus fodder)	56	6.04	338	5	$ 30	45	261	5	40	1	7	......	......
Corn fodder	99	5.70	564	15	120	76	408	5	20	3	16	......	......
Total straw, stover, etc.	230	$4.86	$1,117	20	$150	181	$847	23	$93	6	$27	......	......
Total home-grown	3,239.5	$13.83	$44,787	160	$2,365	1,986.1	$27,408	265.2	$3,472	100.7	$1,332	727.5	$10,210
Purchased:													
Alfalfa	58	$14.43	$837	......	......	58	$837	......	......	......	......	......	......
Mixed hay	52	12.88	670	......	......	46	596	4	$44	......	......	2	$30
Timothy	9	14.33	129	......	......	5	70	......	......	1	$14	3	45
Total purchased	119	$13.75	$1,636	......	......	109	$1,503	4	$44	1	$14	5	$75
Total dry forage	3,358.5	$13.82	$46,423	160	$2,365	2,095.1	$28,911	269.2	$3,516	101.7	$1,346	732.5	$10,285

TABLE 45. AMOUNTS OF FEED USED PER COW AND PER UNIT OF PRODUCT FOR THE YEAR, IN POUNDS

	84 Oxford farms								51 Tully and Homer farms					
	Per cent of cows freshening from September to December, inclusive						All herds		Tully		Homer		Total	
	Less than 25 per cent		From 25 to 50 per cent		More than 50 per cent									
	Per cow	Per 100 pounds of milk produced	Per cow	Per 100 pounds of milk produced	Per cow	Per 100 pounds of milk produced	Per cow	Per 100 pounds of milk produced	Per cow	Per 100 pounds of milk produced	Per cow	Per 100 pounds of milk produced	Per cow	Per 100 pounds of milk produced
Concentrates	1,702	32.3	1,647	28.5	2,069	32.3	1,765	30.8	1,550	25.3	2,575	39.6	2,108	33.3
Silage	4,451	84.5	5,762	99.8	7,136	111.6	5,583	97.5	9,366	152.7	8,804	135.3	9,060	143.0
Other succulent feed	331	6.3	553	9.6	408	6.4	436	7.6	1,475	24.0	693	10.6	1,049	16.5
Dry forage	4,717	89.6	4,255	73.7	4,274	66.8	4,433	77.5	4,079	66.5	3,090	47.5	3,540	55.9
Days of pasture	168	3.2	169	2.9	169	2.6	168	2.9	152	2.5	156	2.4	154	2.4
Acres of pasture	3.7	....	3.6	......	3.3	....	3.6	....	3.3	....	2.4	.....	2.8	....

TABLE 46. AMOUNTS OF FEED USED PER COW PER DAY AND PER UNIT OF PRODUCT

	84 Oxford farms									51 Tully and Homer farms						
	Per cent of cows freshening from September to December, inclusive						All herds		Pasture period, per 100 pounds of milk produced in pasture period	Tully		Homer		Total		Pasture period, per 100 pounds of milk produced in pasture period
	Less than 25 per cent		From 25 to 50 per cent		More than 50 per cent											
	Per cow per day in winter	Per 100 pounds of milk produced in winter period	Per cow per day in winter	Per 100 pounds of milk produced in winter period	Per cow per day in winter	Per 100 pounds of milk produced in winter period	Per cow per day in winter	Per 100 pounds of milk produced in winter period		Per cow per day in winter	Per 100 pounds of milk produced in winter period	Per cow per day in winter	Per 100 pounds of milk produced in winter period	Per cow per day in winter	Per 100 pounds of milk produced in winter period	
Concentrates	7.5	60.5	6.6	43.2	8.3	45.0	7.3	49.2	11.6	6.5	38.8	8.5	46.8	7.9	43.4	17.5
Silage	21.6	173.2	28.0	183.7	35.1	189.8	27.1	182.1	8.7	42.5	253.5	35.6	181.9	38.8	212.1	35.6
Other succulent feed	0.2	1.6	0.4	2.8	0.1	0.3	0.3	1.7	13.8	1.4	8.1	0.5	2.8	0.9	5.0	34.4
Dry forage	23.8	191.2	21.5	141.4	21.8	117.9	22.4	150.4	0.8	18.5	110.0	13.2	67.3	15.6	85.3	10.1
Days of pasture	......	......	......	......	......	......	......	......	6.0	......	......	......	......	......	......	6.2
Acres of pasture	......	......	......	......	......	......	......	......	0.13	......	......	......	......	......	......	0.11

intake, however, varies considerably with the kind of roughage and the richness in protein of the grain used. The Tully and Homer farmers used over 100 pounds more of protein per cow in the winter-period feed than did the Oxford farmers. This was 14 per cent more protein daily. The average production for the year was 11 per cent greater for the Tully and Homer farms. The daily production in the stabling period was 23 per cent higher because of the extra amount of protein used and the greater fall freshening.

TABLE 47. TOTAL AMOUNT AND DERIVATION OF DIGESTIBLE CRUDE PROTEIN AND NET ENERGY USED BY COWS ON 135 FARMS

	Concentrates	Silage (corn)	Other succulent feed	Dry forage	Total
	84 Oxford farms, 2088 cows				
Pasture period (supplementary to pasture):					
Protein:					
Total pounds	120,874	5,100	10,080	1,206	137,260
Per cent	88.1	3.7	7.3	0.9	100.0
Energy:					
Total therms	513,366	60,945	122,016	17,247	713,574
Per cent	72.0	8.5	17.1	2.4	100.0
Winter period:					
Protein:					
Total pounds	491,746	111,474	2,464	384,018	989,702
Per cent	49.7	11.3	0.2	38.8	100.0
Pounds per cow	236	53	1	184	474
Pounds per cow per day	1.20	0.27	0.01	0.93	2.41
Energy:					
Total therms	2,265,174	1,332,114	13,608	3,704,683	7,315,579
Per cent	31.0	18.2	0.2	50.6	100.0
Therms per cow	1,085	638	7	1,774	3,504
Therms per cow per day	5.5	3.3	....	9.0	17.8
Protein-energy ratio, 1:	4.6	11.9	5.5	9.6	7.4
	51 Tully and Homer farms, 1274 cows				
Pasture period (supplementary to pasture):					
Protein:					
Total pounds	98,237	11,240	19,614	26,482	155,573
Per cent	63.2	7.2	12.6	17.0	100.0
Energy:					
Total therms	398,903	134,318	144,646	116,917	794,784
Per cent	50.2	16.9	18.2	14.7	100.0
Winter period:					
Protein:					
Total pounds	398,338	104,180	3,917	232,946	739,381
Per cent	53.9	14.1	0.5	31.5	100.0
Pounds per cow	312	82	3	183	580
Pounds per cow per day	1.48	0.39	0.01	0.87	2.75
Energy:					
Total therms	1,583,412	1,244,951	33,462	1,625,133	4,486,958
Per cent	35.3	27.8	0.7	36.2	100.0
Therms per cow	1,243	977	26	1,276	3,522
Therms per cow per day	5.9	4.6	0.1	6.1	16.7
Protein-energy ratio, 1:	4.0	12.0	8.5	7.0	6.1

In Bulletin 409 of this station, on pages 370, 379, and 382 it is shown that the highest production per cow was obtained when a large proportion of the energy of the winter ration came from concentrates and succulent feed. Of a total of 530 farms with 11,629 cows, studied by the writer at different periods and reported in this and other bulletins listed on page 139, the Tully and Homer group obtained the largest proportion of energy from concentrates and succulent feed (table 49), and had the highest yield of milk per cow.

TABLE 48. AMOUNTS OF DIGESTIBLE CRUDE PROTEIN AND NET ENERGY USED PER COW PER DAY IN WINTER PERIOD, FIVE NEW YORK AREAS

County	Vicinity of	Year	Number of farms	Number of cows	Weight of cows (pounds)	Concentrates	Silage (corn)	Other succulent feed	Dry forage	Total
Protein (pounds):										
Broome	Binghamton and Whitney Point	1914–15	149	2,058	......	1.05	0.18	0.02	0.78	2.03
Herkimer	Newport and Herkimer	1918–19	163	4,136	936	0.84	0.11	0.01	1.14	2.10
Chenango	Norwich	1921–22	83	2,073	908	1.04	0.19	0.01	1.15	2.39
Chenango	Oxford	1921–22	84	2,088	899	1.20	0.27	0.01	0.93	2.41
Cortland	Tully and Homer	1921–22	51	1,274	993	1.48	0.39	0.01	0.87	2.75
Simple average	......	......	......	......	934	1.12	0.23	0.01	0.98	2.34
Energy (therms):										
Broome	......	1914–15	149	2,058	......	4.3	2.2	0.2	7.9	14.6
Herkimer	......	1918–19	163	4,136	936	3.7	1.4	0.1	10.2	15.4
Chenango	......	1921–22	83	2,073	908	5.4	2.3	......	8.8	16.5
Chenango	......	1921–22	84	2,088	899	5.5	3.3	......	9.0	17.8
Cortland	......	1921–22	51	1,274	993	5.9	4.6	0.1	6.1	16.7
Simple average	......	......	......	......	934	5.0	2.7	0.1	8.4	16.2

TABLE 49. DERIVATION OF DIGESTIBLE CRUDE PROTEIN AND NET ENERGY IN WINTER RATIONS OF COWS, FIVE NEW YORK AREAS

County	Vicinity of	Year	Number of farms	Number of cows	Concentrates (per cent)	Succulent feed (per cent)	Dry forage (per cent)	Total
Protein:								
Broome	....	1914–15	149	2,058	51.6	9.9	38.5	100.0
Herkimer	....	1918–19	163	4,136	40.1	5.8	54.1	100.0
Chenango	Norwich	1921–22	83	2,073	43.7	8.3	48.0	100.0
Chenango	Oxford	1921–22	84	2,088	49.7	11.5	38.8	100.0
Cortland	Tully and Homer	1921–22	51	1,274	53.9	14.6	31.5	100.0
Simple average or total	....	....	530	11,629	47.8	10.0	42.2	100.0
Net energy:								
Broome	....	....	......	......	29.7	15.9	54.4	100.0
Herkimer	....	....	......	......	24.3	9.6	66.1	100.0
Chenango	....	....	......	......	32.5	14.4	53.1	100.0
Chenango	....	....	......	......	31.0	18.4	50.6	100.0
Cortland	....	....	......	......	35.3	28.5	36.2	100.0
Simple average	....	....	......	......	30.5	17.4	52.1	100.0
					Ratio, 1:			
Protein-energy ratio 1:								
Broome	....	....	......	......	4.1	11.6	10.1	7.2
Herkimer	....	....	......	......	4.4	12.1	9.0	7.3
Chenango	....	....	......	......	5.1	11.9	7.6	6.9
Chenango	....	....	......	......	4.6	11.8	9.6	7.4
Cortland	....	....	......	......	4.0	11.8	7.0	6.1
Simple average	....	....	......	......	4.4	11.8	8.7	7.0

Pasture

For the Oxford farms the average date of turning out in the spring was May 12 and of stabling in the fall October 26, giving a pasture season of 168 days.

For the Tully and Homer farms the average date of turning out was May 17 and of stabling in the fall October 17. The pasture season here was 154 days.

The average equivalent in acres to open pasture of the land pastured, excluding meadows, was 2.9 per animal unit pastured for the Oxford farms and 2.4 for the Tully and Homer farms.

The average charge for pasture was $5.85 per cow for the Oxford farms and $8.57 per cow for the Tully and Homer farms (table 50). This was the average estimated rental value of the pastures. In addition to this figure, the value of the afterfeed on the meadows averaged $38 per farm for the Oxford farms and $29 per farm for the Tully and Homer farms. Also, for the latter farms, the value of the pasturage on the cabbage fields after the crop was harvested averaged $9 per farm, and the value of refuse harvested and fed, $9 per farm. The absence of cash crops and of alfalfa on the Oxford farms, and the greater prevalence of fences, permitted more pasturing in meadows after the hay was removed than was allowed on the Tully and Homer farms.

The total charge for pasturage averaged $7.41 per cow on the Oxford farms and $10.05 per cow on the Tully and Homer farms, or 14 and 17 cents, respectively, per 100 pounds of milk sold.

TABLE 50. PASTURE CHARGES ON 135 FARMS

	84 Oxford farms			51 Tully and Homer farms		
	Number of animal units pastured	Charge for pasture		Number of animal units pastured	Charge for pasture	
		Total	Per animal unit		Total	Per animal unit
Cows	2,101	$12,285	$5.85	1,268	$10,868	$8.57
Heifers	246.5	1,395	5.66	137	1,305	9.53
Horses and colts	179.5	1,073	5.98	69	369	5.35
Bulls	53	288	5.43	24	200	8.33
Other cattle	3	6	2.00	....	......	....
Meadows pastured after hay was removed	....	$3,196	......	....	$1,486	....
Cabbage bait	....	......	......	....	448	....

The features of a pasture which most largely determine its value as a part of a farm property are:

1. Accessibility to farm buildings.
2. Abundance and quality of feed.
3. Abundance and location of water supply.
4. Character and steepness of surface.
5. Shade.
6. Freedom from swampy areas or stagnant pools.
7. Absence of division by a river; such a division makes crossing for cows necessary.
8. Location so that highly traveled roads or railroads need not be crossed.
9. Slope. Grass starts earlier in the spring and dries out less in the summer on an eastern slope than it does on a western slope.

Of all of these, however, the abundance of feed, the kinds of plants, and the water supply, are the most important considerations. All the other desirable features may be sacrificed to some extent if the pasture furnishes plenty to eat and to drink.

On the Oxford farms 7506 acres, valued at $124,149, were devoted to pasture. The receipts from milk sold during the pasture season amounted to $135,061. The value of feed used supplementary to pasture was $16,798. The returns from the pasture, labor, investment in stock, and other contributing causes besides supplementary feed, were $118,263, which is $1408 per farm, or $15.76 per acre of pasture, in addition to returns from growth of young cattle.

On the Tully and Homer farms there were 3550 acres, valued at $92,039. The summer milk sold amounted to $74,415, the feed supplementary to pasture $18,488; the milk thus being $55,927 above the supplementary feed, which is $1097 per farm, or $15.76 per acre of pasture land, the same per acre of pasture as for the Oxford farms.

The improvement of pasture land that offers some possibility of profitable improvement has been delayed on many farms because of the pressure

TABLE 51. BEDDING USED ON 135 FARMS

Kind of bedding	84 Oxford farms						51 Tully and Homer farms							
	Cows		Heifers		Horses		Cows		Heifers		Herd bulls		Horses	
	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value	Amount (tons)	Value
Home-grown:														
Oat straw	112.5	$958	21.7	$173	66.3	$552	229.3	$2,234	27.2	$255	1.8	$16	108.7	$1,041
Old oat straw	26	222	1	9	5	33	7.5	80	......	......	......	......	1	16
Oat and wheat straw	2	16	......	......	1	8	......	......	......	......	......	......	......	......
Oat and barley straw	......	......	......	......	......	......	71	659	9.3	58	1.2	10	36.5	304
Oat, barley, and spring wheat straw	......	......	......	......	......	......	33	445	1	10	......	......	6	70
Oat, pea, and barley straw	......	......	......	......	......	......	14	84	3	18	1	6	6	36
Wheat straw	10	94	......	......	8	76	12	118	1	11	......	......	14.5	146
Barley straw	......	......	......	......	......	......	10	80	3	15	......	......	4	30
Buckwheat straw	3	14	......	......	1	5	1	7	......	......	......	......	......	......
Rye and vetch straw	......	......	......	......	......	......	2	22	......	......	......	......	......	......
Oat hay	11	100	2	15	8	75	......	......	......	......	......	......	......	......
Hay, 1920	......	......	1	10	1	10	......	......	......	......	......	......	......	......
Sawdust	18	30	......	......	......	......	......	......	......	......	......	......	......	......
Total	182.5	$1,434	25.7	$207	90.3	$759	379.8	$3,729	44.5	$367	4.0	$32	176.7	$1,643
Purchased:														
Salt hay	......	......	......	......	1	$5	......	......	......	......	......	......	......	......
Straw	3.5	$33	......	......	1	5	21	$225	......	......	......	......	7	$86
Sawdust	106.6	178	8.2	$17	14.2	40	46.2	84	......	......	......	......	......	......
Shavings	......	53	......	......	......	1	5.4	58	......	......	......	......	......	......
Total	110.1	$264	8.2	$17	16.2	$51	72.6	$367	......	......	......	......	7	$86
Total bedding	292.6	$1,698	33.9	$224	106.5	$810	452.4	$4,096	44.5	$367	4.0	$32	183.7	$1,729

of more important farm work, altho there is a considerable amount of rough-land pasture on these farms on which it would not pay to spend much time or money. During slack times, it would pay on some farms to cut brush and thorn apples, burn brakes and tree trimmings, drag some of the mossy and run-out areas, and scatter some seed. Pastures receive a large amount of manure, but the distribution is not very complete. If it is considered that the animals void at the same rate during the pasture period as during the winter, cost of bedding is deducted, and allowance is made for some summer manure reaching the crop land, then the manure produced on the pastures would amount to approximately 1.8 tons per acre on the Oxford farms and 2.1 tons per acre on the Tully and Homer farms. Usually the pastures are so inaccessible or so rough, and the stand of grass is so thin, that to apply manure to them thinly with a spreader, as it should be applied, is impractical. On most farms the same manure used as a top dressing for meadows pays better. If the topography is favorable and the stand of grass sufficient, a light top-dressing of lime and acid phosphate might pay on some pastures.

Bedding

Most of the bedding used was home-grown oat straw. The Oxford farms had 3.6 tons of home-grown bedding, and purchased, besides, considerable quantities of sawdust. The other group of farms raised more grain and had 11.9 tons of home-grown bedding per farm (table 51).

The charge for bedding averaged 81 cents per cow on the Oxford farms and $3.22 per cow on the Tully and Homer farms, or 1 cent and 5 cents, respectively, per 100 pounds of milk sold.

Labor

The average rate per hour for operator's labor was 30 cents, for hired labor 24 cents, and for all human labor 26 cents, for the Oxford farms; and for the Tully and Homer farms, 38 cents for the operator's labor, 21 cents, for hired labor and 31 cents for all human labor. The rates for horse labor were 17 cents per hour for the Oxford farms and 16 cents per hour for the Tully and Homer group. The variation in rates asked by operators, and the estimated rates paid for the hired labor, are given in table 52.

The highest rate at which the operator's labor was charged was 60 cents per hour and that of hired men 38 cents per hour. The rates, therefore, are much less than are received for some other kinds of work.

The average rates received for man labor above all other costs in the production of milk were 19.8 cents per hour for the Oxford farms and 24.3 cents for the Tully and Homer farms. The average time spent per cow was 152 hours on the Oxford farms, and 166 hours on the other farms (table 53). This amounts to 2.6 hours in each case per 100 pounds of milk produced for the year. The labor required for the production of 100 pounds of milk in the pasture period was 1.8 hours for the Oxford farms, and 2.0 hours for the Tully and Homer farms. In the winter period the figures were 3.5 and 3.0 hours, respectively.

TABLE 52. VARIATION IN RATES PER HOUR FOR OPERATORS AND HIRED MEN

Rate per hour (cents)	84 Oxford farms				51 Tully and Homer farms			
	Operators		Hired men		Operators		Hired men	
	Number of farms	Per cent	Number of farms	Per cent	Number of farms	Per cent	Number of farms	Per cent
8	......	....	......	....	......	....	2	4.0
10	......	....	......	....	......	....	2	4.0
12	......	....	......	....	......	....	3	6.0
13	......	....	......	....	......	....	3	6.0
14	1	1.2	......	....	......	....	......	....
15	2	2.4	......	....	......	....	4	8.0
16	2	2.4	1	2.7	1	2.0	1	2.0
17	......	....	1	2.7	......	....	1	2.0
18	1	1.2	2	5.4	......	....	2	4.0
19	2	2.4	3	8.1	......	....	1	2.0
20	5	6.0	2	5.4	1	2.0	8	16.0
21	......	....	3	8.1	......	....	1	2.0
22	3	3.6	3	8.1	......	....	3	6.0
23	......	....	3	8.1	2	4.0	......	....
24	......	....	1	2.7	1	2.0	......	....
25	12	14.5	5	13.6	1	2.0	5	10.0
26	......	....	3	8.1	2	4.0	1	2.0
27	2	2.4	1	2.7	......	....	......	....
28	7	8.4	4	10.8	3	6.0	1	2.0
30	16	19.3	......	....	5	10.0	7	14.0
31	......	....	1	2.7	......	....	......	....
32	1	1.2	......	....	1	2.0	......	....
33	5	6.0	1	2.7	4	8.0	......	....
35	10	12.1	1	2.7	......	....	4	8.0
36	......	....	......	....	1	2.0	......	....
38	1	1.2	2	5.4	......	....	1	2.0
40	10	12.1	......	....	8	16.0	......	....
41	......	....	......	....	2	4.0	......	....
42	......	....	......	....	5	10.0	......	....
43	......	....	......	....	1	2.0	......	....
45	1	1.2	......	....	3	6.0	......	....
48	1	1.2	......	....	......	....	......	....
50	1	1.2	......	....	4	8.0	......	....
52	......	....	......	....	1	2.0	......	....
56	......	....	......	....	3	6.0	......	....
60	......	....	......	....	1	2.0	......	....
Total*	83	100.0	37	100.0	50	100.0	50	100.0

* One operator in each group of farms did no work with cows.

Of the total time spent on cows, slightly more than one-half is spent in milking and hauling the milk, and slightly less than one-half in other kinds of labor, such as feeding, caring for the animals, and cleaning the utensils. The average hours, in milking, per cow for the year spent were 63 for the Oxford farms and 71 for the others.

The charge for labor averaged $34.83 per cow on the Oxford farms, and $46.90 per cow on the Tully and Homer farms, amounting to 64 and 77 cents, respectively, per 100 pounds of milk sold.

TABLE 53. LABOR REQUIRED IN PASTURE AND WINTER PERIODS

	Hours in pasture period				Hours in winter period				Total hours			
	Total	Per cow	Per 100 pounds of milk	Total value	Total	Per cow	Per 100 pounds of milk	Total value	Total	Per cow	Per 100 pounds of milk	Total value
	84 Oxford farms											
Human labor for cows:												
Hauling milk	15,211	7.3	0.3	$ 3,869	19,374	9.3	0.3	$ 4,927	34,585	16.6	0.2	$ 8,796
Milking	63,558	30.4	1.1	16,399	67,373	32.3	1.1	17,384	130,931	62.7	1.1	33,783
Other human labor	24,775	11.9	0.4	6,393	126,155	60.4	2.1	32,551	150,930	72.3	1.3	38,944
Total	103,544	49.6	1.8	$26,661	212,902	102.0	3.5	$54,862	316,446	151.6	2.6	$81,523
Total except milk hauling	88,333	42.3	1.5	$22,792	193,528	92.7	3.2	$49,935	281,861	135.0	2.4	$72,727
Horse labor for cows:												
Hauling milk	20,068	9.6	0.4	$3,339	29,137	14.0	0.5	$4,847	49,205	23.6	0.4	$8,186
Other horse labor	1,104	0.5	.....	184	15,155	7.3	0.2	2,528	16,259	7.8	0.1	2,712
Total	21,172	10.1	0.4	$3,523	44,292	21.3	0.7	$7,375	65,464	31.4	0.5	$10,898
Human labor for heifers	569	.....	.....	$141	12,053	.....	.....	$2,996	12,622	.....	.....	$3,137
Horse labor for heifers	.....	.....	.....	.....	484	.....	.....	$77	484	.....	.....	$77
	51 Tully and Homer farms											
Human labor for cows:												
Hauling milk	6,790	5.3	0.2	$ 2,003	10,918	8.6	0.2	$ 3,222	17,708	13.9	0.2	$ 5,225
Milking	38,097	29.9	1.2	11,775	52,940	41.5	1.1	16,364	91,037	71.4	1.1	28,139
Other human labor	19,387	15.2	0.6	5,993	82,898	65.1	1.7	25,623	102,285	80.3	1.3	31,616
Total	64,274	50.4	2.0	$19,771	146,756	115.2	3.0	$45,209	211,030	165.6	2.6	$64,980
Total except milk hauling	57,484	45.1	1.8	$17,768	135,838	106.6	2.8	$41,987	193,322	151.7	2.4	$59,755
Horse labor for cows:												
Hauling milk	9,475	7.4	0.3	$1,521	19,576	15.4	0.4	$3,141	29,051	22.8	0.4	$4,662
Other horse labor	3,793	3.0	0.1	601	20,651	16.2	0.4	3,274	24,444	19.2	0.3	3,875
Total	13,268	10.4	0.4	$2,122	40,227	31.6	0.8	$6,415	53,495	42.0	0.7	$8,537
Human labor for heifers	792	.....	.....	$242	5,937	.....	.....	$1,814	6,729	.....	.....	$2,056
Horse labor for heifers	.....	.....	.....	.....	3,198	.....	.....	$556	3,198	.....	.....	$556

Hauling milk

The average distance from the farms to the milk plants for the Oxford group was 3.0 miles and for the Tully and Homer group 3.1 miles. The charges for hauling milk are given in table 54. They amounted to 21 cents per hundred pounds, or $11.23 per cow, for the Oxford dairies, and 19 cents per hundred pounds or $11.38 per cow, for the Tully and Homer dairies. Automobiles and trucks were used to a greater extent on the Oxford farms than on those of the other group.

Of the Oxford farmers, 15 hired their milk hauled thruout the entire season, 62 hauled or cooperated in hauling, and 7 hauled part distance and hired the remaining distance.

Of the Tully and Homer farmers, 11 hired their milk hauled, 33 hauled or cooperated in hauling, and 7 both hauled and hired hauled thruout the entire season. In April, 1922, the milk from 15 poolers was trucked by the Dairymen's League Cooperative Association, Inc., to Apulia or Dryden.

TABLE 54. CHARGES FOR HAULING AND DELIVERING MILK TO STATION

	84 Oxford farms			51 Tully and Homer farms		
	Pasture period	Winter period	Total	Pasture period	Winter period	Total
Human labor:						
Number of farms	67	66	.....	39	41	....
Hours	15,211	19,374	34,585	6,790	10,918	17,708
Value	$3,869	$4,927	$8,796	$2,003	$3,222	$5,225
Horse labor:						
Number of farms	50	58	....	28	41	....
Hours	20,068	29,137	49,205	9,475	19,576	29,051
Value	$3,339	$4,847	$8,186	$1,521	$3,141	$4,662
Value of total human and horse labor	$7,208	$9,774	$16,982	$3,524	$6,363	$9,887
Hauling hired:						
Number of farms	....	....	24	....	....	21
Cash paid	....	....	$3,772	....	....	$3,311
Use of automobiles and trucks:						
Number of farms	....	....	18	....	....	8
Value	....	....	$3,529	....	....	$1,297
Total charges for milk hauling	....	....	$24,283	....	....	$14,495
Amount received for milk hauling	....	....	$845	....	....	....
Total net cost of milk hauling	....	....	$23,438	....	....	$14,495
Hundredweight of milk hauled	....	....	113,655	....	....	77,316
Cost per hundredweight	....	....	$0.21	....	....	$0.19

Use of buildings

The average charge for the use of buildings was $6.51 per cow for the Oxford farms and $9.18 per cow for the others. The charge per 100 pounds of milk was 12 cents and 15 cents, respectively. The data for the charges are given in table 55:

TABLE 55. CHARGES FOR USE OF BUILDINGS ON 135 FARMS

	84 Oxford farms	51 Tully and Homer farms
Value of barns and other buildings used for dairy cattle	$174,025	$165,450
Interest at 5 per cent	$8,700	$8,273
Taxes	3,489	2,256
Insurance	726	577
Repairs and depreciation	3,241	2,345
Total	$16,156	$13,451
Charged to:		
Cows	$13,583	$11,698
Heifers	1,945	1,302
Herd bulls	628	451
Total	$16,156	$13,451

Of the Oxford farmers, 80 had the barns arranged so that the cows faced outward, and drove through for the manure. Seventy-seven farms had straight stanchions, and 7 had swing stanchions. Of the floors, 47 were concrete, 3 were both concrete and wood, and 34 were wood. Twenty-one of the farms had water buckets, and 63 watered cows in yard tubs or in creeks or springs adjacent to the farm.

Of the Tully and Homer farmers, 47 had barns arranged so that the cows faced outward, and 44 drove through for the manure. Twenty-six of the farms had straight stanchions, and 25 swing stanchions. Of the floors, 48 were concrete, 2 were wood, and 1 was both concrete and wood. Nineteen farmers had water buckets in the barn, and 32 watered the cows in the yards, mangers, or creeks.

Use of equipment

The charge for the use of equipment was $1.53 per cow for the Oxford farms, and $2.09 per cow for those in the other section. The charge per 100 pounds of milk was 3 and 4 cents, respectively. The average value of equipment used per farm was $315 for the Oxford farms and $302 for the other farms. Interest, repairs, depreciation, insurance, and other charges on the equipment per farm, amounted to $42.13 for the Oxford farms and $59.27 for those in the Tully and Homer group. All charges for the use of special cattle equipment amounted to 13.4 and 19.6 per cent, respectively, of the value of the equipment for the two groups of farms.

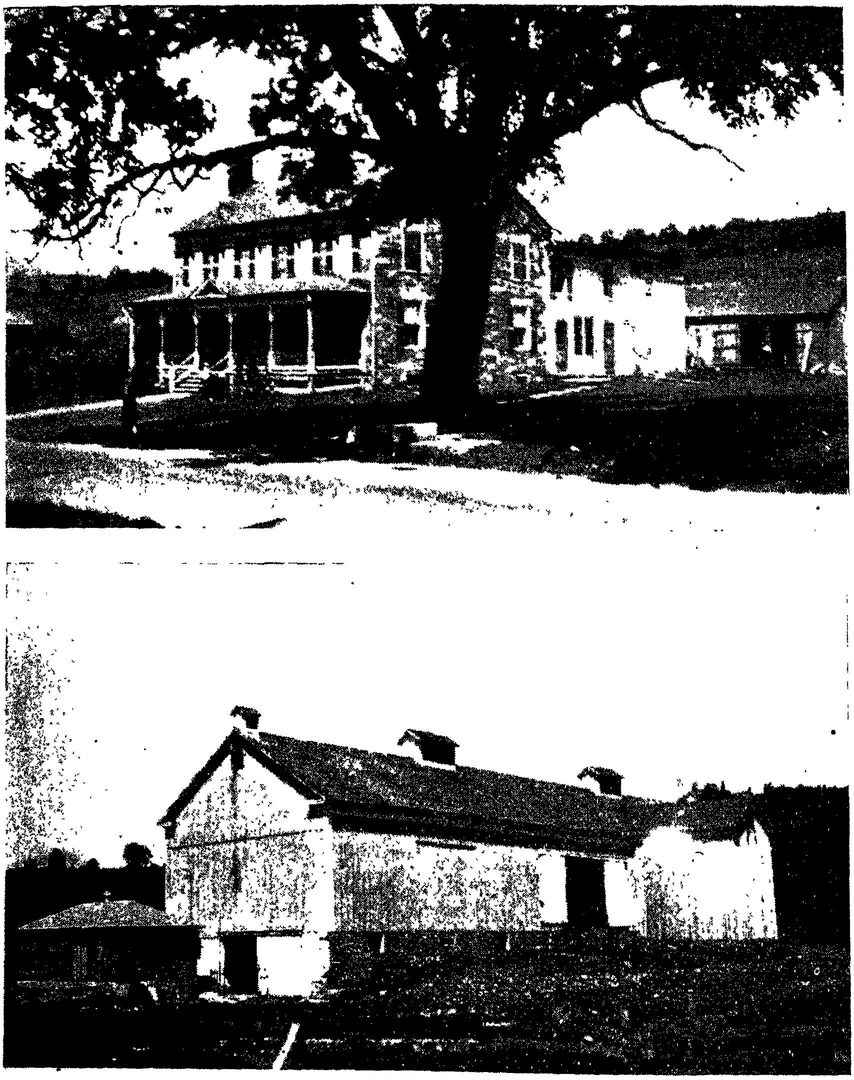

FIGURE 15. MAIN BUILDINGS OF GRADE A FARM SHOWN ON COVER
(435 acres, 68 cows)

Interest

The charge for interest on cows amounted to $4.48 per cow, or 8 cents per 100 pounds of milk, for the Oxford farms, and $5.59, or 9 cents per 100 pounds, for the Tully and Homer group.

The value of the animals and the amount of interest charged are given in table 56.

TABLE 56. INTEREST ON CATTLE ON 135 FARMS.

	Cattle units	Value	Interest
	84 Oxford farms		
Cows	2,087.8	$155,835	$9,351
Heifers	304.6	19,400	1,164
Herd bulls	92.0	5,906	356
Bull calves to be sold	0.6	29	2
Total	2,485.0	$181,170	$10,873
	51 Tully and Homer Farms		
Cows	1,274.5	$118,687	$7,123
Heifers	153.0	11,942	714
Herd bulls	48.8	4,728	283
Bull calves to be sold	1.8	175	10
Total	1,478.1	$135,532	$8,130

Depreciation on cows

The average value of grade cows was $70.22 for the Oxford farms and $87.48 for those in the other group, and of purebreds $162.36 and $155.38, respectively. The depreciation was $3.86 per head, or 7 cents per 100 pounds of milk, for the Oxford group, and $3.79, or 6 cents per 100 pounds of milk, for the Tully and Homer group. The depreciation averaged 5.2 and 4.1 per cent, respectively, of the average inventoried value of cows.

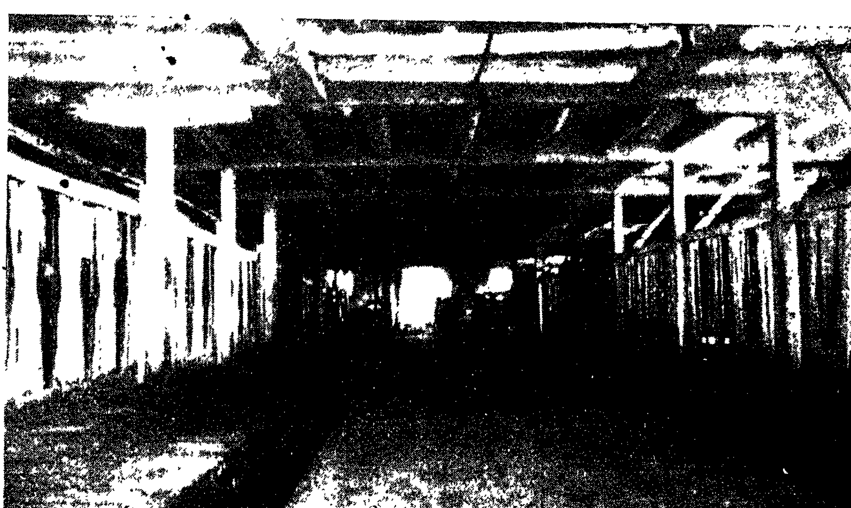

FIGURE 16. INTERIOR OF BARN SHOWN IN FIGURE 15

The average of the Oxford farmers' estimates as to decrease in the market value of cows per head was $26.43 for grades, and that for the Tully and Homer group of farms was $23.02 for grades and $23.89 for purebreds.[8]

On the Oxford farms, 23.1 per cent, or nearly one-fourth, of the cows were replaced, while on the other farms 24 per cent were replaced. About 45 per cent on the former farms and 41 per cent on the latter were replaced by heifers raised at home, and 55 and 59 per cent, respectively, were replaced by purchase.

The average number of weeks during which cows were dry was 8.4 for the Oxford farms and 7.6 for the Tully and Homer farms. The average weight of cows was 899 pounds on the former farms and 993 pounds on the latter farms.

Many of the cows purchased by farmers are bought at dispersal auctions, or from dealers. The cows bought from dealers usually come from more remote regions, sometimes where creameries or cheese factories are located. Dairymen who run spring dairies have little use for fall-fresh cows, and often sell them at what appears to the winter dairymen to be a sacrifice. On the other hand, those who run fall dairies often sell cheaply cows that are not expected to freshen until spring, add some more money to the returns of the sale, and buy a fresh cow.

Bull service

The kinds of and the charges for the concentrates, succulent feed, dry forage, milk, and pasture used by herd bulls, and their appreciation or depreciation, were estimated in the field. The average cost of keeping 95 herd bulls was $61.03 per cattle unit for the Oxford farms, and that of keeping 50 herd bulls was $104.20 per cattle unit for the Tully and Homer farms (table 57). This is $2.72 and $4.00 per cow kept, or 5 cents and 7 cents per 100 pounds of milk sold, for the two respective groups. The appreciation on bulls averaged $6.26 per cattle unit for the Oxford farms, and the depreciation for the Tully and Homer farms was $1.64 per cattle unit.

On the 84 Oxford farms 23 herd bulls were purchased, and on the 51 Tully and Homer farms 13 were purchased. Of all of these bulls, 37 per cent were purebred. A good way to introduce abortion trouble is to buy a bull that has been used in other herds, which many farmers are doing. A good way to prevent some of this trouble and loss, and at the same time get calves more worth raising, is to buy a good young purebred bull ready for service, which more farmers should do.

A great many farmers, especially breeders of purebred stock suffer the nuisance and cost of their neighbor's roaming scrub bull. The hard times and the scarcity of labor have resulted in less than the usual attention being given to pasture fences. Some of these fences never were horse-high, and they now are certainly not bull-tight. There is very little reason why a farmer should be allowed to pasture his bull when his part of the line fence will not keep the animal where he belongs. Process of the law will not correct this; the remedy is to correct the conscience of the negligent neighbor.

[8]For the year ending April 30, 1919, the average increase in market value of cows per head as estimated by 163 Herkimer County farmers was $33.62. (Relation of the composition of rations on some New York dairy farms to the economics of milk production. By E. G. Misner. Cornell Univ. Agr. Exp. Sta., Memoir 64, 1923, p. 19.)

TABLE 57. COST OF BULL SERVICE ON 135 FARMS

	84 Oxford farms				51 Tully and Homer farms			
	Total		Per cattle unit		Total		Per cattle unit	
	Amount	Value	Amount	Value	Amount	Value	Amount	Value
Costs:								
Concentrates	603 cwt.	$1,108	655 lbs.	$12.04	399 cwt.	$ 732	818 lbs.	$15.00
Silage and other succulent feed	87.6 tons	536	1,904 lbs.	5.83	205.5 tons	1,068	8,422 lbs.	21.89
Dry forage	171 tons	2,844	3,717 lbs.	30.91	101.7 tons	1,346	4,168 lbs.	27.58
Whole milk	5,317 lbs.	120	58 lbs.	1.30	1,560 lbs.	49	32 lbs.	1.00
Pasture	....	288	....	3.13	....	200	....	4.10
Interest	....	356	....	3.87	....	283	....	5.80
Net depreciation	....	....	....	....	....	80	....	1.64
Use of buildings	....	628	....	6.83	....	451	....	9.24
All other costs	....	1,803	....	19 60	....	1,565	....	32.07
Total	....	$7,683	....	$83.51	....	$5,774	....	$118.32
Returns:								
Net appreciation	....	$ 576	....	$ 6.26	....	....	....	....
Manure	756 tons	1,456	8.2 tons	15.83	393 tons	$689	8.1 tons	$14.12
Service	....	36	....	0.39	....	....	....	....
Total	....	$2,068	....	$22.48	....	$689	....	$14.12
Cost of keeping own herd bull	....	$5,615	....	$61.03	....	$5,085	....	$104.20
Service hired	....	$62	....	....	....	$14	....	....
Net cost of bull service	....	$5,677	....	....	....	$5,099	....	....
Net cost per cow	....	$2.72	....	....	....	$4.00	....	....
Number of herd bulls	....	95.0	....	....	....	50.2	....	....
Cattle units of herd bulls	....	92.0	....	....	....	48.8	....	....

Miscellaneous charges

The remaining expenses of producing milk are given in table 58. The most important of these expenditures are for salt, gasoline, oil, veterinary fees, ice and sawdust for ice, and insurance on cows. These amount to $2.78 per cow, or 5 cents per 100 pounds of milk, for the Oxford farms, and $3.87 per cow, or 6 cents per 100 pounds of milk, for those in the Tully and Homer group.

TABLE 58. MISCELLANEOUS EXPENSES FOR COWS

Item	Charge: 84 Oxford farms	Charge: 51 Tully and Homer farms
Salt	$ 708	$ 682
Feed grinding	71	83
Electric lights, carbide, etc.	337	32
Insurance	419	316
Veterinary inspection	10	....
Coal, oil, gasoline	1,363	904
Farm upkeep and operation of automobiles	491	250
Ice and sawdust for ice	520	847
League deductions	31	56
Cow-tester acids	139	....
Spray materials	78	228
Hydrated lime	22	37
Telephone	197	439
Veterinary fees	995	1,046
Any other farm expenses	427	2
Total	$5,808	$4,922

RETURNS

Milk and milk products

The amounts of and returns for milk sold have been given in tables 26 and 27 (pages 42 and 44). The average was $124.53 in cash and $7.52 in certificates of indebtedness per cow for the Oxford farms, and $154.38 in cash and $4.42 in certificates of indebtedness for the Tully and Homer farms.

The average amount of milk used by the Oxford operators' families was 2959 pounds per family, and by the Tully and Homer families 2708 pounds per family. The average amount of milk kept at home for all purposes for the year was 6757 pounds per farm for the Oxford farms, and 6694 for the Tully and Homer farms. The average production of milk per cow was 5724 pounds for the Oxford group, and 6337 pounds for the Tully and Homer group. Less than 5 per cent of the milk was kept at home. The returns for milk products sold and milk and its products used on the farms are given in table 59. The total amount of milk produced on the Oxford farms was 11,951,333 pounds, and on the Tully and Homer farms 8,072,938 pounds.

TABLE 59. RETURNS FROM MILK PRODUCTS SOLD AND MILK AND ITS PRODUCTS USED ON THE FARM

	2088 cows, 84 Oxford farms			1274 cows, 51 Tully and Homer farms		
	Number of farms	Number of pounds of product	Total value	Number of farms	Number of pounds of product	Total value
Milk products sold:						
Butter	1	20	$ 8	..	....	.....
Milk sold retail	1	18,293	538	..	....	.....
Milk used:						
Operators' families	84	248,542	$5,696	50	135,410	$3,240
Landlords' families	2	3,140	71	2	5,495	120
Hired men's families	13	20,118	470	8	15,712	430
Total milk used	84	271,800	$6,237	50	156,617	$3,790
Milk products used:						
Butter:						
Family	3	1,020	394	1	365	164
Skimmilk:						
Poultry	..	....	.....	1	8,000	16
Total milk and its products used, except that fed to cattle	84	272,820	$6,631	51	164,982	$3,970
Milk fed:						
Heifers	66	201,615	$4,491	37	104,702	$2,753
Veals	29	70,527	1,632	19	67,608	1,844
Bull calves to be sold	..	....	.....	1	2,520	78
Bull calves to be kept for herd bulls	13	6,757	146	2	1,560	49
Total milk fed to cattle	74	278,899	$6,269	45	176,390	$4,724
Milk products fed:						
Skimmilk:						
Veals	2	9,850	41	..	....	.....
Heifers	1	6,000	30	..	....	.....
Total milk products fed to cattle	3	15,850	$71	..	....	.....
Total milk and its products fed to cattle	74	294,749	$6,340	45	176,390	$4,724
Equivalent, in pounds of milk, of milk and its products used	84	567,569	.....	51	341,372	.....
Pounds of fat in milk retailed, milk products sold, and milk and its products used	..	21,050	.....	..	11,975	.....

The average yield of cows on the Oxford farms during the stabling period was 2932 pounds, or 14.9 pounds per day; and during the pasture period 2792 pounds, or 16.6 pounds per day. For the Tully and Homer farms, the stabling-period yields were 3855 pounds per cow, or 18.3 pounds per

TABLE 60. NUMBER OF CALVES BORN DURING YEAR, AND THEIR VALUE AT BIRTH

	84 Oxford farms					51 Tully and Homer farms				
	Number of farms	Number of calves	Per cent	Value	Value of each at birth	Number of farms	Number of calves	Per cent	Value	Value of each at birth
Heifers to be raised or sold:										
Purebred	66 { 11	36	1.9	$1,135	$31.53	38 { 13	46	3.9	$1,214	$26.39
Grade	62	225	11.9	846	3.76	28	112	9.5	476	4.25
Bulls to be kept:										
Purebred	10 { 3	3	0.1	12	4.00	4 { 4	4	0.3	130	32.50
Grade	7	7	0.4	27	3.86		......	......	......	....
Bulls sold or to be sold:										
Purebred	5 { 3	6	0.3	50	8.33	4 { 3	16	1.4	251	15.69
Grade	2	2	0.1	7	3.50	1	1	0.1	5	5.00
Calves vealed or to be vealed	81	1,516	80.0	4,181	2.76	49	939	79.6	2,692	2.87
Calves deaconed	17	100	5.3	......	......	10	62	5.2	......	....
Deacon hides	12	(70)	......	48	0.69	2	(5)	......	2	0.40
Total calves born alive*	84	1,895	100.0	$6,306	$3.33	51	1,180	100.0	$4,770	$4.04
Live calves per 100 cows	....	91	......	......	......	....	93	......	......	....
Calves born dead	45	111	......	......	......	25	80	......	......	....
Dead calf hides	7	16	......	10	......	....	......	......	......	....
Total credited to cows	....	......	......	$6,316	......	....	......	......	$4,770	....
Cows that would not breed	28	40	......	......	......	8	12	......	......	....
Cows with unsound quarters	71	185	......	......	......	38	87	......	......	....

* The total number of calves exceeds the number of cows calving by one in each group, because of twins in both the Oxford and the Tully and Homer group.

cow per day; and the pasture-period yields were 2482 pounds, or 16.1 pounds per cow per day.

The returns from all milk not sold wholesale averaged $6.48 per cow for the Oxford farms and $6.83 per cow for the Tully and Homer farms.

Calves born during the year

Of the calves born during the year, 5.5 per cent on the Oxford farms and 6.3 per cent on the Tully and Homer farms were born dead. On the Oxford farms, 1.9 per cent of the cows on hand at the end of the year failed to breed; on the Tully and Homer farms the number was 1 per cent. On the Oxford farms, 8.8 per cent of the cows, and on the Tully and Homer farms 6.8 per cent of the cows, on hand at the end of the year had unsound quarters.

The value of calves at birth for the Oxford and the Tully and Homer farms, respectively, was as follows: purebred heifers, $31.53 and $26.39; grade heifers, $3.76 and $4.25; calves vealed or to be vealed, $2.76 and $2.87; and all live calves born during the year, $3.33 and $4.04 per head (table 60). Of the total calves born on the Oxford and also on the Tully and Homer farms, 85 per cent were vealed or deaconed.

Most abnormal calvings are probably due to abortion. The resulting decrease in production is a serious problem. From the standpoint of financial importance to the dairyman, tuberculin testing is receiving more attention than it should, compared to that paid to control of abortion. Practically all milk for New York City is now pasteurized, so that the risk of tuberculosis developing from the milk supply is very small indeed. For every animal disposed of for tuberculosis, outside of the wholesale slaughters from campaigning, the dairyman probably loses two from abortion troubles and their consequences.

The returns from calves and calf hides averaged $3.02 per cow, or 6 cents per 100 pounds of milk, for the Oxford farms, and $3.74 per cow, or 6 cents per 100 pounds of milk, for the Tully and Homer farms.

Manure

The average value of manure per ton at the barnyards was $1.92 for the Oxford farms, and $1.75 for the Tully and Homer farms. Manure was

TABLE 61. MANURE RECOVERED FROM CATTLE AND HORSES

	All stock	Cows	Heifers	Herd bulls	Bull calves to be sold	Horses
	84 Oxford farms					
Manure recovered (tons)	20,293	14,923	2,201	756	3	2,410
Value at $1.92 per ton at the barnyard	$38,960	$28,653	$4,226	$1,456	$6	$4,619
	51 Tully and Homer farms					
Manure recovered (tons)	14,051	10,533	1,233	393	16	1,876
Value at $1.75 per ton at the barnyard	$24,593	$18,435	$2,158	$689	$28	$3,283

ɔ cattle at this value. The amount recovered from cows was er cow for the Oxford farms, and 8.3 tons per cow for the Tully er farms. The data are given in table 61.

dit for manure averaged $13.72 per cow, or 25 cents per 100 milk sold, for the Oxford farms, and $14.47 per cow, or 24 100 pounds sold, for the Tully and Homer farms.

Miscellaneous returns

lue of the feed bags credited to cows was the principal miscel- eturn, amounting to 12 cents per cow for the Oxford farms and per cow for the Tully and Homer farms.

SUMMARY OF COSTS AND RETURNS

osts and returns of the dairy enterprise for each group of farms narized in tables 62 and 63. The net cow cost of producing milk ;9 per 100 pounds for the Oxford farms, and $2.79 per 100 pounds Tully and Homer farms. The herd cost of milk was slightly n each area than the cow cost, because of the loss on young cattle. cost per pound of butterfat was 72 cents for the Oxford farms cents for the Tully and Homer farms.

concentrates at $37.33, silage at $6.25, and dry forage at $15.88, , and labor at 26 cents per hour, the average loss was $9.04 per cow Oxford farms; in addition to that amount, there was an average e in the market value of cows of $26.43 per head. The loss per ınds of milk sold was 17 cents.

ı concentrates at $37.16, silage at $5.24, and dry forage at $13.82, ı, and labor at 31 cents per hour, the average loss was $10.73 on ılly and Homer farms, in addition to an average decrease in the t value of cows of $23.02 per head. The loss per 100 pounds of old was 18 cents. As previously stated, however, after all charges for labor were made, the returns for milk production on the Oxford were 20 cents per hour, and on the Tully and Homer farms 24 cents our, for all the time spent on the enterprise.

e returns per hour above all other costs for the Tully farms were cents, and for the Homer farms 35.8 cents. The total income per on the Homer farms was $200.20, which was $6.87 higher than the . On the Tully farms the total income was $164.54 per cow, or $31.80 than the costs. On the Oxford farms the income per cow was .39, or $9.04 less than the total costs of $164.43.

ne use of the word "loss" is frequently criticized on the basis that if s were as indicated, the business would cease. This is not so. A farmer be out of debt, receive interest, live on it, but receive no real wages. tainly, then, he operates at a loss. Likewise, if he has a definite alter- ive opportunity to receive 35 cents an hour for his time and he fore- s this to run a business for which he receives less, the difference is , altho he may continue to run the business.

n Bulletin 409 of this experiment station, on page 309, the detailed costs producing milk for the year ending April 30, 1915, on 149 farms in ome County, are reported. The costs on the Oxford farms in 1921 here orted, as compared with the costs on the Broome farms in 1914 — seven

TABLE 62. SUMMARY OF COSTS AND RETURNS

	2088 cows, 84 Oxford farms		1274 cows, 51 Tully and Homer farms	
	Per cow	Per 100 pounds of milk sold wholesale	Per cow	Per 100 pounds of milk sold wholesale
Costs:				
Concentrates	$33.45	$0.62	$40.59	$0.67
Succulent feed	18.58	0.34	26.45	0.44
Dry forage	34.94	0.64	24.55	0.40
Pasture	7.41	0.14	10.05	0.17
Bedding	0.81	0.01	3.22	0.05
Human labor	34.83	0.64	46.90	0.77
Horse labor	1.30	0.02	3.04	0.05
Use of buildings	6.51	0.12	9.18	0.15
Use of equipment	1.53	0.03	2.09	0.04
Milk hauling	11.23	0.21	11.38	0.19
Interest on cows	4.48	0.08	5.59	0.09
Depreciation on cows	3.86	0.07	3.79	0.06
Bull service	2.72	0.05	4.00	0.07
Miscellaneous	2.78	0.05	3.87	0.06
Total costs	$164.43	$3.02	$194.70	$3.21
Returns:				
Milk sold wholesale:				
Cash	$124.53	$2.28	$154.38	$2.54
Certificates of indebtedness	7.52	0.14	4.42	0.07
Milk products sold, and milk retailed	0.26	....	......	....
Milk and milk products used, except that fed to cattle	3.18	0.06	3.12	0.05
Milk and milk products fed to cattle	3.04	0.06	3.71	0.06
Calves and calf hides	3.02	0.06	3.74	0.06
Manure	13.72	0.25	14.47	0.24
Miscellaneous	0.12	....	0.13	0.01
Total returns	$155.39	$2.85	$183.97	$3.03
Loss	$9.04	$0.17	$10.73	$0.18
Cow cost of producing milk	$141.09	$2.59	$169.53	$2.79
Herd cost of producing milk	......	$2.68	......	$2.90
Cow cost per pound of butterfat	......	$0.72	......	$0.80

years previous, and just preceding the war — taken as 100, were as follows: concentrates, 152; succulent feed, 158; dry forage, 165; pasture, 157; bedding, 62; human labor, 136; horse labor, 125; milk hauling, 112; use of buildings, 145; use of equipment, 300; interest on cows, 125; bull service, 263; depreciation on cows, 127; miscellaneous, 152; total cost, 146. The price of milk, without Grade A premiums, on the Oxford farms in 1921 was 132 per cent of the price on the Broome farms in 1914, while the cost of production was 146 per cent of that on the Broome farms.

ℒE 63. COSTS AND RETURNS FOR COWS ON TULLY AND HOMER FARMS

	Tully		Homer	
	Per cow	Per 100 pounds of milk sold wholesale	Per cow	Per 100 pounds of milk sold wholesale
ıtrates	$31.28	$0.54	$48.39	$0.77
ənt feed	28.44	0.49	24.78	0.39
rage	27.16	0.47	22.37	0.36
ə	10.39	0.18	9.76	0.16
g	3.77	0.07	2.75	0.04
ı labor	48.07	0.83	45.93	0.73
.abor	3.04	0.05	3.04	0.05
buildings	9.49	0.16	8.93	0.14
equipment	3.13	0.05	1.22	0.02
auling	14.83	0.26	8.50	0.13
.t on cows	5.39	0.09	5.76	0.09
iation on cows	2.87	0.05	4.55	0.07
rvice	4.45	0.08	3.62	0.06
laneous	4.03	0.07	3.73	0.06
otal costs	$196.34	$3.39	$193.33	$3.07
old wholesale:				
ı	$132.45	$2.28	$172.71	$2.74
ificates of indebtedness	6.26	0.11	2.87	0.05
nd milk products used, except that to cattle	3.33	0.06	2.94	0.05
nd milk products fed to cattle	4.82	0.08	2.78	0.04
and calf hides	3.64	0.07	3.83	0.06
'e	13.96	0.24	14.90	0.24
laneous	0.08	....	0.17	....
otal returns	$164.54	$2.84	$200.20	$3.18
	......	....	$6.87	$0.11
	$31.80	$0.55	......	....
per hour of human labor above all costs	......	$0.122	......	$0.358

variation in the cost of producing milk is shown in table 64. Of ord farms, 34 produced milk at less than $2.50 per hundredweight, n 6 farms the cost was over $4.00. Of the Tully and Homer farms, uced at a cost of less than $2.50 and 3 at a cost of over $4.00. cow cost of milk ranged from $1.70 to $4.25 on the Oxford farms m $1.92 to $4.86 on the Tully and Homer farms.

udying the results from various regions, the question of the adjust- f milk prices in their relation to feed prices always arises. Milk were quite evidently more favorable in the Oxford than in the h area, and most favorable in the Tully and Homer section 65). When milk prices are more than one and one-fourth times

TABLE 64. VARIATION IN COST OF PRODUCING MILK ON 84 OXFORD AND 51 TULLY AND HOMER FARMS

	Less than \$2.50	From \$2.50 to \$3.00	From \$3.01 to \$3.50	From \$3.51 to \$4.00	From \$4.01 to \$4.50	More than \$4.50
Oxford farms:						
Per cent of cows freshening from September to December inclusive:						
Less than 25	10	11	10	3	3	..
From 25 to 50	14	9	4	1	2	..
More than 50	10	6	..	..	1	..
Total Oxford farms	34	26	14	4	6	..
Tully and Homer farms:						
Tully	5	12	4	7	..	1
Homer	9	6	2	3	2	..
Total Tully and Homer farms	14	18	6	10	2	1

TABLE 65. PRICE AVERAGES AND RATIOS

	Chenango County (Norwich) 1921	Chenango County (Oxford) 1921	Onondaga and Cortland Counties (Tully and Homer) 1921
Per cent of pounds of concentrates fed to cattle (purchased)	96.9	96.9	91.2
Per cent of pounds of concentrates fed to cattle (home-grown)	3.1	3.1	8.8
Average price per ton of concentrates	\$37.09	\$37.81	\$38.41
Ratio of price of concentrates to price of hay per ton, 1:	0.45	0.43	0.38
Ratio of price of concentrates to average price of silage, 1:	0.17	0.17	0.14
Per cent of tons of hay fed to cattle (purchased)	4.1	2.5	4.8
Per cent of tons of hay fed to cattle (leguminous)	18.8	25.2	60.0
Average price per ton of hay fed to cattle	\$16.65	\$16.43	\$14.62
Average price per ton of other dry forage fed to cattle	\$5.57	\$7.69	\$4.86
Average price per ton of silage fed to cattle	\$6.24	\$6.25	\$5.24
Ratio of price of concentrates per 100 pounds to price of milk, 1:	1.10	1.29	1.36
Ratio of price of silage per 100 pounds to price of milk, 1:	6.58	7.84	10.08
Ratio of price of hay per 100 pounds to price of milk, 1:	2.46	2.96	3.59
Ratio of price of concentrates per 100 pounds to average price received for milk in stabling period, 1:	1.09	1.28	1.41
Ratio of price of corn silage per 100 pounds to average price received for milk in stabling period, 1:	6.52	7.81	10.42
Ratio of price of hay per 100 pounds to average price received for milk in stabling period, 1:	2.43	2.95	3.71

of grain, or more than three times the price of hay, price con-
re favorable for dairying.

ıtio of the price of milk to the prices of feed and to wages is an ent which has more bearing than any other on the prosperity farmers, and should also be closely followed in regulating the eness of practices.

COST OF RAISING HEIFERS

ıly less than one-half of the cows replaced are raised at home. rage number of 2.8 heifers freshened for the first time on the Oxford and 2.5 on the Tully and Homer farms.

average age at which heifers freshened for the first time was 28.1 on the Oxford farms, and 29.1 months on the Tully and Homer The variations in age at first freshening are shown in table 66.

E 66. AGE OF HEIFERS FRESHENING FOR FIRST TIME, AND THEIR VALUE

Age (months)	84 Oxford farms		51 Tully and Homer farms	
	Number	Value	Number	Value
....	1	$ 20	..	......
....	2	100	..	......
....	1	45	..	......
....	5	300	3	$ 375
....	2	140	1	125
....	75	4,073	22	1,720
....	6	460	1	100
....	24	1,395	11	940
....	6	410	4	375
....	1	35	3	225
....	3	180	..	......
....	60	3,685	57	4,180
....	1	80	..	......
....	3	200	1	75
....	..	......	12	900
....	1	75	..	......
....	40	2,705	11	805
....	1	150	..	......
Total..........	232	$14,053	126	$9,820

average value of heifers at first freshening was $56.62 for grades and 2.50 for purebreds on the Oxford farms, and $72.11 for grades and 3.33 for purebreds on the Tully and Homer farms.

he cost of raising heifers until they are two years of age was least, .70, on the Oxford farms, was next highest, $114.40, on the Tully farms, was most expensive, $128.57, on the Homer farms (table 67). Since the rage ages of freshening were 28 and 29 months, one-sixth at least uld be added to these amounts to complete the cost up to the time of shening.

The cost was greater for herds with a larger number of fall-freshening ws than it was for herds with spring-freshening cows.

	84 Oxford farms									51 Tully and Homer farms						
	All herds			Per cent of cows freshening from September to December, inclusive						All herds			Tully		Homer	
				Under 25 per cent		From 25–50 per cent		Over 50 per cent								
	Total		Amount per cattle unit	Total		Total		Total		Total		Amount per cattle unit	Total		Total	
	Amount	Value		Amount	Value	Amount	Value	Amount	Value	Amount	Value		Amount	Value	Amount	Value
Costs:																
Whole milk (pounds)	201,615	$4,491	662	75,232	$1,644	83,186	$1,772	43,197	$1,075	104,702	$2,753	684	60,938	$1,539	13,761	$1,214
Skimmilk (pounds):																
Farm	6,000	30	20	......	......	6,000	30	......	......	......	......	......	......	......	......	......
Purchased	540	5	2	......	......	540	5	......	......	......	......	......	......	......	......	......
Grain (pounds)	2,033.5	3,678	668	604.5	1,083	911	1,641	518	954	1,285.5	2,367	840	463	873	822.5	1,491
Silage (pounds)	373.7	2,331	2,454	108.5	675	163	1,018	102.2	638	631.5	3,281	8,255	395.5	2,044	236	1,237
Other succulent feed (pounds)	2.6	17	17	2.1	15	......	......	0.5	2	7	27	92	4	12	3	15
Hay (pounds)	566.5	9,061	3,720	253.2	3,869	185.3	2,936	128	2,256	216.2	3,423	3,218	143.9	1,914	102.3	1,509
Other dry forage (pounds)	16.5	125	108	15.5	110	......	......	1	15	23	93	301	23	93	......	......
Pasture	......	1,395	......	......	550	......	560	......	285	......	1,305	......	......	746	......	559
Bedding (tons)	33.9	224	223	9.5	59	8.2	57	16.2	108	44.5	367	582	28	187	16.5	180
Human labor (hours)	12,622	3,137	41	4,716	1,187	5,151	1,239	2,755	711	6,729	2,056	44	4,002	1,171	2,727	885
Horse labor (hours)	484	77	2	182	28	180	30	122	19	3,198	556	21	1,681	339	1,517	217
Use of buildings	......	1,945	......	......	762	......	702	......	481	......	1,302	......	......	825	......	477
Use of equipment	......	342	......	......	121	......	126	......	95	......	357	......	......	283	......	74
Interest on stock	......	1,164	......	......	456	......	448	......	260	......	714	......	......	359	......	355
Miscellaneous	......	123	......	......	73	......	35	......	15	......	130	......	......	70	......	60
Total costs	......	$28,145	......	......	$10,632	......	$10,599	......	$6,914	......	$18,731	......	......	$10,455	......	$8,276
Returns:																
Manure (tons)	2,201	$ 4,226	7.2	862	$1,654	867	$1,663	472	$ 909	1,233	$2,158	8.0	685	$1,201	548	$ 957
Appreciation	......	13,800	......	......	5,758	......	5,402	......	2,640	......	9,178	......	......	5,021	......	4,157
Miscellaneous	......	25	......	......	......	......	20	......	5	......	......	......	......	......	......	......
Total returns	......	$18,051	......	......	$7,412	......	$7,085	......	$3,554	......	$11,336	......	......	$6,222	......	$5,114
Difference (loss)	......	$10,094	......	......	$ 3,220	......	$3,514	......	$3,360	......	$ 7,395	......	......	$4,233	......	$3,162
Value at birth, plus purchases, less sales and hides	......	1,576	......	......	1,315	......	451	......	— 190	......	1,871	......	......	653	......	1,218
Cost of raising a heifer to two years of age	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Total	......	25,495	......	......	10,293	......	9,387	......	5,815	......	18,444	......	......	9,907	......	8,537
Per cattle unit	......	83.70	......	......	82.61	......	80.09	......	92.60	......	120.55	......	......	114.40	......	128.57
Number of cattle units	304.6	......	......	124.6	......	117.2	......	62.8	......	153.0	......	......	86.6	......	66.4	......

TABLE 68. COWS FRESHENING BY MONTHS

	84 Oxford farms								51 Tully and Homer farms					
	All herds		Per cent of cows freshening from September to December, inclusive						Tully and Homer		Tully		Homer	
			Under 25 per cent		From 25 to 50 per cent		Over 50 per cent							
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
1921:														
May	134	6.7	55	7.3	66	8.2	13	2.9	44	3.5	14	2.4	30	4.4
June	58	2.9	30	4.0	19	2.4	9	2.0	9	0.7	2	0.4	7	1.0
July	39	1.9	18	2.4	17	2.1	4	0.9	13	1.0	4	0.7	9	1.3
August	61	3.0	22	2.9	28	3.5	11	2.4	61	4.9	31	5.4	30	4.4
September	144	7.2	16	2.1	75	9.4	53	11.7	202	16.1	60	10.5	142	20.7
October	177	8.8	25	3.3	59	7.4	93	20.6	188	14.9	67	11.7	121	17.6
November	180	9.0	27	3.6	71	8.9	82	18.1	137	10.9	56	9.8	81	11.8
December	184	9.2	36	4.8	90	11.3	58	12.8	104	8.3	53	9.3	51	7.4
1922:														
January	158	7.9	65	8.6	58	7.2	35	7.8	97	7.7	51	8.9	46	6.7
February	229	11.4	113	15.0	91	11.4	25	5.5	134	10.6	73	12.8	61	8.9
March	352	17.6	185	24.5	130	16.3	37	8.2	139	11.0	83	14.5	56	8.1
April	289	14.4	162	21.5	95	11.9	32	7.1	131	10.4	78	13.6	53	7.7
Total	2,005	100.0	754	100.0	799	100.0	452	100.0	1,259	100.0	572	100.0	687	100.0

FALL OR SPRING FRESHENING

On the Oxford farms, 34.2 per cent of the cows freshened from September to December inclusive. On the Tully farms this figure was 41.3 per cent, and on the Homer farms 57.5 per cent. The distribution is given in table 68.

The average labor income was higher with fall freshening. The production was 1133 pounds more per cow. On the Oxford farms, the returns per hour of labor on cows above all other costs were 14 cents with less than 25 per cent of the cows freshening in the fall, 22.4 cents with from 25 to 50 per cent freshening in the fall, and 26 cents with over 50 per cent of the cows freshening in the fall (table 72).

The question naturally rises in this connection concerning the relation of milk prices in the winter to the normal summer-winter price ratio. A comparison of the normal seasonal variation in the price of milk at shipping stations in New York, corrected for trend, and the seasonal variation in the monthly prices of milk for summer and winter dairies, is given in tables 69 and 70. The monthly prices for milk, arranged by seasonal groups, for the Oxford farms are given in table 70. From these data, it appears that the winter prices were higher as compared to the summer prices than they were normally. This favors the winter dairyman.

TABLE 69. NORMAL SEASONAL VARIATION IN PRICES FOR MILK AT SHIPPING STATIONS IN THE NEW YORK TERRITORY*

Month	From 1868 to 1879	From 1880 to 1896	From 1897 to 1913
January	107	115	116
February	108	106	111
March	107	103	104
April	95	95	96
May	80	81	87
June	79	76	76
July	86	82	83
August	88	92	90
September	89	104	97
October	110	109	107
November	125	118	113
December	126	119	120
Average	100	100	100

* Computed from data furnished by *The Milk Reporter*, Sussex, New Jersey, thru correspondence.

When the general price level changes upward or downward, the seasonal variation in milk prices on a percentage basis may be expected to change. A 10-per-cent change on \$2.00 milk for June would be 20 cents a hundred, or slightly less than ½ cent a quart. A 10-per-cent change on \$3.20 milk in October would be 32 cents a hundred, or more than half again as much per quart. The producer is more concerned with the amount per hundredweight than with the percentage change.

TABLE 70. MONTHLY PRICES FOR MILK, BY SEASONAL GROUPS, OXFORD FARMS

	Per cent of cows freshening from September to December, inclusive					
	Less than 25 per cent		From 25 to 50 per cent		More than 50 per cent	
	Price	Per cent	Price	Per cent	Price	Per cent
1921:						
May	$2.15	83	$2.11	86	$2.18	86
June	1.84	71	1.82	74	1.89	75
July	2.21	86	2.16	88	2.30	91
August	2.78	108	2.71	110	2.82	112
September	2.92	113	2.80	114	2.91	115
October	3.31	128	3.10	126	3.22	128
November	3.22	124	3.01	122	3.09	123
December	3.19	123	3.01	122	3.01	119
1922:						
January	2.90	112	2.64	107	2.68	106
February	2.67	103	2.48	101	2.48	98
March	2.18	84	2.03	83	2.07	82
April	1.68	65	1.64	67	1.65	65
Simple average for year	$2.59	100	$2.46	100	$2.52	100

TABLE 71. RELATION OF SEASON OF FRESHENING TO VARIOUS FACTORS

	84 Oxford farms			
	Per cent of cows freshening from September to December, inclusive			
	Less than 25 per cent	From 25 to 50 per cent	More than 50 per cent	Average
Number of farms	37	30	17	84
Number of cows	786	824	478	2,088
Cows per farm	21.2	27.5	28.1	24.9
Average capital per farm	$11,019	$13,696	$16,280	$ 13,040
Average labor income per farm	$123	$514	$301	$299
Average labor income per farm at pool prices	$39	$458	$207	$222
Pounds of milk produced per farm	111,834	158,521	179,872	142,278
Pounds of milk produced per cow	5,264	5,771	6,397	5,724
Per cent of milk sold from November to April, inclusive	40.5	46.4	51.8	45.8
Butterfat test of milk (per cent)	3.64	3.54	3.56	3.58
Per cent of cows freshening from September to December, inclusive	13.8	37.0	63.2	34.2
Cost of milk per 100 pounds	$2.868	$2.435	$2.470	$2.592
Price received per 100 pounds	$2.468	$2.371	$2.456	$2.426
Weight of cows (pounds)	896	901	903	899

TABLE 72. COSTS AND RETURNS FOR COWS IN THREE SEASONAL GROUPS, FOR 84 OXFORD FARMS

	Per cent of cows freshening from September to December, inclusive					
	Under 25 per cent		From 25 to 50 per cent		Over 50 per cent	
	Per cow	Per 100 pounds of milk sold wholesale	Per cow	Per 100 pounds of milk sold wholesale	Per cow	Per 100 pounds of milk sold wholesale
Costs:						
Concentrates	$31.34	$0.63	$31.97	$0.58	$39.49	$0.64
Succulent feed	14.86	0.30	19.39	0.35	23.30	0.38
Dry forage	36.04	0.73	34.74	0.63	33.49	0.54
Pasture	7.07	0.14	7.76	0.14	7.38	0.12
Bedding	0.77	0.02	0.81	0.01	0.89	0.01
Human labor	36.90	0.75	31.25	0.57	37.60	0.61
Horse labor	1.46	0.03	1.47	0.03	0.73	0.01
Use of buildings	6.03	0.12	6.55	0.12	7.21	0.12
Use of equipment	1.32	0.03	1.40	0.03	2.09	0.03
Milk hauling	14.59	0.29	10.03	0.18	7.75	0.13
Interest on cows	4.47	0.09	4.34	0.08	4.72	0.08
Depreciation on cows	5.21	0.11	2.09	0.04	4.67	0.08
Bull service	2.85	0.06	2.36	0.04	3.13	0.05
Miscellaneous	2.55	0.05	2.67	0.05	3.36	0.05
Total costs	$165.46	$3.35	$156.83	$2.85	$175.81	$2.85
Returns:						
Milk sold wholesale:						
Cash	$115.63	$2.34	$122.48	$2.23	$142.72	$2.32
Certificate of indebtedness	6.25	0.13	8.00	0.15	8.79	0.14
Milk products sold, and milk retailed	0.68	0.01	......	......	0.02	....
Milk and milk products used, except that fed to cattle	3.50	0.07	3.27	0.06	2.47	0.04
Milk and milk products fed to cattle	3.45	0.07	2.63	0.05	3.06	0.05
Calves and calf hides	2.90	0.06	2.79	0.05	3.63	0.06
Manure	13.18	0.27	14.01	0.25	14.12	0.23
Miscellaneous	0.09	......	0.11	.....	0.16	....
Total returns	$145.68	$2.95	$153.29	$2.79	$174.97	$2.84
Gain	.....	.....	......	......	......	....
Loss	$19.78	$0.40	$3.54	$0.06	$ 0.84	$0.01
Returns per hour of human labor above all other costs	.....	$0.14	......	$0.224	......	$0.26

The difference between production per cow in herds of chiefly fall-fresh cows and herds of chiefly spring-fresh cows depends primarily on the prices of the product, and on the availability of green feed for main-

taining the production of the spring-fresh cows. The payment of a Grade A premium is an inducement to force fall-fresh cows for greater production. At the same time it is fully as difficult to maintain the yields of the spring-fresh cows. The difference in production between spring-fresh and fall-fresh cows is therefore greater when a premium is paid than when ordinary prices for milk are realized (table 73). When alfalfa is available for use with pasture, the difference between the yields of the spring-fresh and of the fall-fresh herds is much less; also the difference in cost is less. The spring-fresh cow can be made to keep up her yield so well with this very highly nitrogenous green feed, that the cost per unit is kept down.

TABLE 73. RELATION OF SEASON OF FRESHENING TO YIELD AND TO COST OF MILK WITH DIFFERENT SYSTEMS OF FARMING

Per cent of cows freshening from September to December, inclusive	Condensery (Norwich farms)		Grade A without cash crops (Oxford farms)		Grade B with alfalfa (Munnsville farms)	
	Pounds of milk per cow	Cost per 100 pounds of milk	Pounds of milk per cow	Cost per 100 pounds of milk	Pounds of milk per cow	Cost per 100 pounds of milk
Less than 25	4,980	$2.86	5,264	$2.87	6,335	$2.46
From 25 to 50	5,042	2.91	5,771	2.44	6,444	2.59
More than 50	6,025	2.35	6,397	2.47	6,915	2.42
Difference between first and third groups	+1,045	-$0.51	+1,133	-$0.40	+580	-$0.04
Per cent of increase in yield and decrease in cost, third group over first	21.0	17.8	21.5	13.9	9.2	1.6

On the Oxford farms, 37 per cent of the cows were less than five years old, and 47 per cent were from five to eight years old. On the Tully and Homer farms, 41 per cent were less than five years old, and 47 per cent were from five to eight years old. (Table 74.) On the Oxford farms 16 per cent were more than eight years old, while on the Tully and Homer farms 12 per cent were of that age. In spite of the fact that more heifers were raised in the Oxford region, the percentage of young cows was less and the percentage of very old cows higher there than on the Tully and Homer farms.

The depreciation on individual cows is not a fixed amount each year A cow may continue to be worth for sale all that she ever was worth, until the last year of her usefulness, when failure to breed, udder trouble, disease, or injury suddenly depreciates her to a beef or a rendering value. The suddenness with which this may be expected is greater as the age advances. Therefore, from the standpoint of prevention of this heavy depreciation for any individual farmer, it is to his advantage to be skillful enough to sell animals before this wrecking comes. But this is only passing it along to the other fellow, and might be considered cleverness of practice rather than praiseworthy preventive methods.

TABLE 74. AGES OF COWS ON HAND APRIL 30, 1922

Age, in years	84 Oxford farms								51 Tully and Homer farms					
	Per cent of cows freshening from September to December, inclusive						All herds		Tully		Homer		Tully and Homer	
	Less than 25		From 25 to 50		Over 50									
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
2–3	84	10.5	78	9.5	48	10.0	210	10.0	48	8.4	103	14.8	151	11.9
3–4	100	12.5	94	11.4	59	12.3	253	12.0	62	10.8	117	16.8	179	14.1
4–5	111	13.9	129	15.6	81	16.9	321	15.2	86	15.0	109	15.6	195	15.3
5–6	175	21.8	120	14.5	75	15.7	370	17.6	112	19.5	121	17.4	233	18.3
6–7	108	13.5	160	19.4	85	17.7	353	16.8	108	18.8	100	14.3	208	16.4
7–8	110	13.7	109	13.2	44	9.2	263	12.5	80	13.9	74	10.6	154	12.1
8–9	44	5.5	65	7.9	40	8.4	149	7.1	43	7.5	34	4.9	77	6.1
9–10	20	2.5	43	5.2	29	6.0	92	4.4	18	3.1	13	1.9	31	2.4
Over 10	49	6.1	27	3.3	18	3.8	94	4.4	17	3.0	26	3.7	43	3.4
Total	801	100.0	825	100.0	479	100.0	2,105	100.0	574	100.0	697	100.0	1,271	100.0

ORGANIZATION OF THE BUSINESS

A discussion of several combinations of enterprises with the dairy will bring out their advantages and disadvantages.

LIVESTOCK

Purebred cattle

Nothing seems to have yet been found that may be substituted for milk and leguminous roughage for supplying calcium to the bones of growing cattle or milch cows. To get good-sized, thriving animals, with large, strong bones and teeth, plenty of milk (or skimmilk) must be given them when they are calves. To be successful, the purebred breeder must grow animals well. This is expensive to do when milk, concentrates, hay, and labor are high-priced. When these conditions prevail, more money is usually made by concentrating on the production of milk rather than the raising of young cattle. A higher-producing and better type of grade cow than of purebred cow can be obtained for the same amount of money. So if animals are to be raised, it will pay better to raise a good grade than a poor purebred; and when raised, a good grade will sell for nearly as much. The better half of the grade cows of the country are better producers than the poorer half of the purebreds. Therefore, it would now pay some purebred breeders better to buy the best heifer calves from some grade herds now replaced by purchase, raise them, and veal some or all of their own heifer calves. Most purebred bull calves have to be vealed, anyway.

The chief purpose in keeping cattle is to provide milk. The number of milch cows in New York has remained about the same for many years. From an economic standpoint, the proper place for raising animals is in a region where the cost of raising and of transportation to places of desired use is least. The proper place for the purebred industry is, therefore, not in close proximity to metropolitan milk markets, but on less favorably situated farms in the more remote parts of the country. The feed required to raise a cow will produce from two to four times as much milk as the weight of the cow. A cow not only weighs less, but also is less perishable for shipping long distances, than the milk. It is seldom fully realized that New York can produce an enormous quantity of city milk by (1) shifting to more winter milk and using the other half of the supply produced for fluid milk instead of for manufactured products, (2) increasing the amount of production from cows it already has, (3) increasing the number of cows on farms now in operation, and (4) buying cows from distant areas or States instead of raising them in intensive, well-located, milk-shipping regions. The place for purebreds and for the raising of animals is in a region where there is less demand for fluid milk.

Raising heifers on certain farms or in certain regions where milk can be disposed of at a premium above the ordinary wholesale market price not only is expensive, but also may result in the use of roughage and possibly of home-grown concentrates for growing young cattle; whereas, if there were no young cattle, the feed might be used more profitably in the production of milk. In both of the Grade A districts under study, more cows were purchased than were raised; that is, cows were purchased

from near-by surplus areas, having been brought into these areas to be milked.

In regions where either land, labor, or roughage, is high in price, it is not good business, and it is not the practice, to raise many cattle. Highly priced tillable land can be more profitably used to grow cash crops than to grow winter feed for growing cattle. Grade A producers who are skillful in choosing animals will make the most money by concentrating on milk production.

Persons who have given more attention to the husbandry than to the fiscal questions concerned sometimes assert that the only sure way to be a successful dairyman is to raise one's own cattle. The arguments for this contention that are usually advanced are: (1) certainty as to parentage of the cattle, (2) better disease prevention and control, (3) proper development and growth of animals, and (4) prevention of the risk of buying discarded cows. The often disregarded arguments against raising the cows are: (1) low production from young animals, (2) use of labor and roughage that might more profitably go toward producing milk, and (3) cost of raising animals.

The records obtained by this survey were divided into three groups: one including all those farms replacing cows entirely by purchase; another, those farms replacing cows only by raising; and a third, those farms adding cows during the year both by purchase and by raising. For the Tully and Homer farms the results are shown in table 75. The farms

TABLE 75. RELATION OF DIFFERENT METHODS OF REPLACING COWS TO VARIOUS FACTORS, 51 TULLY AND HOMER FARMS

	Cows added to herd during year		
	All purchased	Some raised and some purchased	All raised
Number of farms	14	16	21
Acres per farm	183.4	176.7	151.5
Cows per farm	32.3	25.2	20.
Cattle units per farm	34.2	29.9	24.8
Total number of cows	452.5	402.5	419.5
Cows added during year:			
Number	94	140	70
Per cent of number on hand	20.8	34.8	16.7
Per cent added by purchase	100	60	0
Per cent of cows freshening from September to December, inclusive	51.5	50.2	48.6
Per cent of cows of various ages:			
Less than 5 years	37.0	45.5	41.8
From 5 to 8 years	52.3	43.8	43.8
More than 8 years	10.7	10.7	14.4
Depreciation on cows per cow	$6.91	$3.96	$0.26
Pounds of milk produced per cow	6,821	6,142	5,994
Value of milk sold per cow	$188	$148	$138
Crop sales per farm	$1,507	$1,916	$1,593
Labor income per farm	$1585	$1380	$477
Cost of milk per 100 pounds sold	$2.82	$2.71	$2.84
Price received for milk per 100 pounds	$2.83	$2.52	$2.44

adding cows entirely by purchase were larger; they had 62 per cent larger herds of milkers, 38 per cent more cattle units, and a larger proportion of cows of mature age, obtained 827 pounds more milk per cow at the same cost per 100 pounds, and had a labor income of $1108 more per farm, than those farms that added cows exclusively by raising. Farms that used both methods of replacement came in between, in most of these respects. There was practically no difference in crop sales per farm in each group.

Of the Oxford farms, 14 replaced cows entirely by purchase. The average labor income of these farms was $247. Forty-four replaced entirely by raising and had an average labor income of $430. If all farms replacing two-thirds or more by purchase were grouped, the average labor income would be minus $11. Apparently, in the Oxford region, where crop land is cheaper, pasture land more abundant and cheaper, cash crops not generally grown, and the price for milk not so high, as at Homer, the farmers who raise their cows are doing equally well, if not better, than those who replace by purchase.

Poultry

Very rarely is a large commercial flock of poultry found on a farm with a large dairy. On the 135 Grade A farms here reported, there were only 5 flocks of over 200 fowls at the end of the year. The commercial flocks are almost exclusively kept by those who specialize in the poultry business. The replacement of a flock of 1000 would necessitate starting from 1000 to 1200 chicks. The very prevalent, erroneous idea that chickens must be reared in small flocks results in so much labor being expended that the enterprise is at once eliminated. Also, the critical time in rearing comes during April and May, the months when a dairy farmer is busiest getting the crops planted and the cows cared for in the barn. In short, the labor in raising the chickens and caring for the eggs interferes so much with field and barn work that the dairy farmer does not raise poultry, altho in some instances it would pay better than some of the farm work. Other reasons why poultry is not kept in larger numbers on dairy farms are: the lack of buildings, the shortage of straw, the absence of corn for grain, and of wheat (since these crops are not usually grown on a dairy farm), the impatience of men with the puttering work that chickens require, and the fact that young chickens naturally die so easily.

CASH CROPS

The opportunity for producing cash crops, together with the possibility of obtaining premiums for the production of low-count milk, is rather limited in New York. The system of farming by which most of the milk is produced is straight dairying with no side lines. This study, therefore, does not indicate average conditions of dairying, but only specialized systems which combine other enterprises or a price premium with the dairy. The usual way of emphasizing the importance of side lines has been to compare individual farms. Unless particular care is made in the selection of the farms, erroneous conceptions of the economic importance of the other enterprises are likely to result. In organizing this survey, of which the results are being reported in this series of bulletins, it was planned to substitute a comparison of groups of farms by areas,

for the comparison of individual records that is so often made, anticipating by such contrasts to discover with greater accuracy the real contribution to the labor income from other enterprises or sources of income.

In a period of declining prices following a period of high war prices, however, and especially in one of low prices for marketable crops, the combination milk-and-crop farmer loses some of his advantage. His farm has increased in value more than the straight milk farm, and consequently the interest charges are more. He is forced to hire more of the continuing high-priced labor, only to gamble on the price outlook. His fertilizer bills are high, his taxes have been increased more, and a few other expenses remain higher. Thus the operating expense of his business remains higher than that of the straight milk farm. When crop prices are low, an actual cash loss in their production sometimes occurs.

The leading cash crops on the Tully and Homer farms were potatoes, cabbage, hay, and factory peas.

Potatoes

When potatoes are grown as a cash crop on the dairy farm they are usually planted in small acreages. The reasons are that on dairy farms only small acreages are in crop land, that the crop land is frequently rough, wet, or too heavy, or that cow-feed crops pay better than small acreages of potatoes. In valleys the air drainage is usually poorer, the temperature higher, and fogs more prevalent, than on the uplands. The control of blight is therefore more difficult in the valleys than it is in the elevated regions. Potato-growing requires machinery which would be too expensive to own for use on a small acreage. This crop conflicts more with corn for the silo, both at planting and harvesting, than does cabbage and requires more labor. Also, potatoes are not so valuable for stock feeding as cabbage is. In short, they are less profitable for dairy farms than is cabbage.

The average yield of potatoes in the Tully and Homer area, where an average of 4.5 acres per farm were grown, was 135 bushels, and the average price received for those sold was 95 cents per bushel. Thus the gross value of the crop was $128 per acre, about twice the gross value per acre of the cannery-pea crop. But the year under study was one of favorable potato prices. The next year they sold for about half of this.

Cabbage

The raising of cabbage fits in well with the other work on a dairy farm. The land may be plowed to advantage in the fall. Setting comes the last of June, between spring planting and the first corn and potato cultivations and haying. The control of weeds is not so difficult as it is with corn and potatoes, because the plants can be cultivated in a few days after setting. This can be done mornings during haying. No spraying is required. The crop is excellent to use after corn in the crop rotation, thus reducing the area to be seeded. In regions of heavy hay yields it is not necessary to seed large areas annually. Harvesting comes late in October or early in November, giving plenty of time for silo filling, potato digging, and harvesting of second crops of clover. The cabbage crop can be readily stored by "laying down," and this provides wages

for extra winter work with the normal increase in the price of cabbage. But above all, the plant is very stimulating to milk production; and if prices do not justify marketing, the crop can be fed. When this happens, silage and hay are saved and more milk is produced than on ordinary rations. Most dairy farmers say that there is more money in cabbage than in any other crop that they can grow.

The average yield of cabbage per acre in the Tully and Homer area was 10.1 tons, on an average of 3.3 acres per farm. The average price received for cabbage sold was $31.37 per ton, the gross value $317 per acre. These figures do not include refuse, of which the smaller part was harvested and the greater pastured. As with potatoes, this was a year of exceptionally high prices, with the prices of cabbage even higher. The next year, cabbage sold for from $7 to $8 a ton in the fall, which meant low per-hour wages but still a very good gross income per acre.

Varying the acreage in different years, in order to have a large crop when the price will be high and a smaller crop in a year of generally heavy production, is not usually successful. The chief difficulty is in forecasting at the time of making the seedbed the size of the country's crop.

Cabbage makes an excellent crop to use before seeding. Some of the liberal application of the commercial fertilizer, and more of the lime applied for the crop, is available for the succeeding nurse crop and seeding. The lime is applied to the surface for the cabbage crop and turned under by plowing, where it is ready to help when the clover or alfalfa roots get down to it; and the lime applied with the nurse crop gives the roots a good start.

The markets for cabbage are with local dealers at Homer and Tully. There are storage houses at each of these places, the aggregate capacity of four houses at Homer being over 2000 tons. For cabbage to carry thru storage in the best condition, the heads should not be over ripe. Cabbage set too early in June is too mature for best storage cabbage, especially if the cold weather holds off too long in the fall.

The control of diseases affecting cabbage is an important matter. The liberal use of lime early in the spring, or in the previous fall, on the ground to be planted with cabbage, is one of the most effective methods of controlling club root. Frequently, lime is used just before setting, but this application is too late. Not until a farmer loses a crop in a year of high prices does he fully appreciate the importance of exactness in these measures of control. Also, the spreading of manure from infected refuse or heads on land to be used for cabbage the following year is likely to infect the cabbage field. Aside from the labor problem, some of the most careful growers have concluded that the risk of spreading disease is too great to justify harvesting the refuse. When the cabbage is "baited off," animals are allowed on the fields for only a short time during the day.

The seed must be treated and the bed limed, to insure obtaining club-free plants.

Peas for the cannery

Cannery peas are grown in the Tully and Homer area under contract, mostly for the David Harum Canning Company, of Homer, and the Yager and Halstead Company, of Cortland. The companies furnish the seed and deduct the cost from the value of the crop. The peas are hauled to a

viner, and the silage is either taken back from a stack later by the farmer at about \$2 a ton, or kept by the companies, or sold by farmers to the farm on which the viner is located. Peas grow best in a cool season and in moderately moist soil. The yield for 38 acres grown in the Tully and Homer area was 1642 pounds per acre. At the average price of \$77 per ton, the gross returns were \$2393, or \$63 per acre. The expense for seed is approximately \$16 per acre, so that \$47 per acre remains as gross returns for the crop. Farmers nearest the viner get a considerable amount of refuse for manure in return for opening the stack.

Peas are harvested earlier than oats, and this advantage, together with their leguminous characteristics, makes the crop an excellent nurse crop for seeding. Especially after the early varieties of peas, a good crop of hay can be harvested the same year if the season is not too dry. Oats are harvested too late for a crop of hay to follow. This fact is considered in cost accounting, and the farmer considers it in deciding whether oats or peas shall be the nurse crop. The other things he considers are labor conflicts, the influence on the following seeding, the need for bedding and the cost of purchasing it, and the direct financial returns from peas or crops that might be grown in their stead.

The pea crop does not offer the opportunity of realizing exceptionally large profits that cabbage and potatoes do, because the price of peas is set by contract. Besides, it carries the chance for loss because of low yields. Hence the pea crop seldom competes with these others for a place in the farming system, but it is an alternative usually for spring grain, which likewise offers no chance of bringing in large returns because of the extensive competition in its production.

The distribution of the income on the Oxford farms is expressed by the milk receipts. On the Tully and Homer farms, the income from crops is more important than on the Oxford farms and most of it is received from October on thru the winter. The critical time in both areas, from the standpoint of financing the business, is in the spring, when fertilizer, seed, and spraying material are to be purchased, unless interest and principal payments are due at some other time during the year.

The financial risk involved with a diversified dairy farm is lessened to a minimum. The income from milk is certain, and when there is a combination of several cash crops in the system, a failure or low prices for all crops is not likely to occur. If the milk-feed price ratio is not favorable, the possibility that crops may sell for relatively high prices insures against the serious loss that would result with a specialized business.

SIZE OF BUSINESS

The variation in the size of the business on 135 farms in the two areas, as measured by number of cows and by man equivalent, is shown in table 76. There was a total of 28 farms that furnished employment for the equivalent of three men or more for the entire year. A total of 33 farms had more than 30 cows. On the larger farms, the cost of milk production was less and the living costs per family more than on the smaller farms. This is true for both the Oxford and the Tully and Homer regions. While the living costs were higher on the larger farms, it is possible that the families were larger.

TABLE 76. VARIATION IN SIZE OF BUSINESS, 135 FARMS

Man equivalent	Number of cows per farm: Less than 18	From 18 to 30	More than 30	Total
	84 Oxford farms			
1.0 to 1.4	13	2	0	15
1.5 to 1.9	5	9	4	18
2.0 to 2.4	6	15	4	25
2.5 to 2.9	0	9	4	13
3.0 and over	0	4	9	13
Total	24	39	21	84
	51 Tully and Homer farms			
1.0 to 1.4	2	0	0	2
1.5 to 1.9	5	5	0	10
2.0 to 2.4	5	7	2	14
2.5 to 2.9	2	6	2	10
3.0 and over	3	4	8	15
Total	17	22	12	51

The Tully and Homer farms with the larger business made lower labor incomes than those with the smaller business (table 77). The reason for this is chiefly that the smaller farms include a few very intensive, highly successful, combination milk-and-cabbage farms, while the larger ones include those farms with poorer cows and less effective organization generally. Also, a larger proportion of Tully farms, where milk prices were not so high, appear in the larger farm groups. Therefore, results for these areas would not present the true significance of volume of business in its relation to success in farming or to reducing the cost of production.

TABLE 77. SIZE OF FARM BUSINESS AS RELATED TO VARIOUS FACTORS

	Acres operated per farm: Less than 125	From 125 to 250	More than 250
	84 Oxford farms		
Number of farms	24	39	21
Acres operated	90	178	343
Acres of crops	34	62	100
Number of cows	15	23	39
Pounds of milk produced per cow	5,841	5,847	5,536
Capital	$8,377	$12,484	$19,401
Labor income	$168	$256	$527
Cost of milk per 100 pounds	$2.83	$2.65	$2.41
Cash living costs per family	$599	$693	$715

TABLE 77 (*concluded*)

	Acres operated per farm		
	Less than 125	From 125 to 200	More than 200
	51 Tully and Homer farms		
Number of Tully farms	8	12	9
Number of Homer farms	8	9	5
Total number of farms	16	21	14
Acres operated	95	163	260
Acres of crops	53	70	108
Number of cows	21	26	28
Pounds of milk produced per cow	6,514	6,465	6.005
Capital	$15,953	$18,413	$24,105
Labor income	$1,533	$948	$704
Cost of milk per 100 pounds	$2.71	$2.92	$2.69
Cash living costs per family	$973	$943	$1,130

RATES OF PRODUCTION

The relationship of large crop yields and good production from animals, to labor income, has been reported so many times that it seems unnecessary to consider it here except to present a table showing the very great importance of high production per cow in obtaining a good reward for the year's labor (table 78). It is hoped that the results previously given pertaining to feeding will encourage feeders to make a more critical analysis of their practices, keeping in mind adjustments in rations that will give better production per cow. Of course, on some farms better animals are needed. Good land plus good animals plus good farmers is a combination for successful farming that is hard to surpass. Rates of

TABLE 78. RELATION OF PRODUCTION PER COW TO VARIOUS FACTORS

	Pounds of milk produced per cow			
	Less than 5000	From 5000 to 6000	From 6001 to 7000	More than 7000
	84 Oxford farms			
Number of farms	23	33	16	12
Number of cows	533	906	382.5	266.3
Cows per farm	23.2	27.5	23.9	22.2
Pounds of milk produced per cow	4,342	5,614	6,396	7,901
Per cent of cows freshening from September to December, inclusive	23.1	30.0	37.8	44 0
Cost of milk per 100 pounds sold	$3.05	$2.56	$2.34	$2.47
Average labor income	—$116	+$396	+$599	+$426
Cost of raising a heifer to two years of age	$80.07	$85.19	$81.14	$92.14

TABLE 78 (*concluded*)

	Pounds of milk produced per cow			
	Less than 5000	From 5000 to 6000	From 6001 to 7000	More than 7000
	51 Tully and Homer farms			
Number of farms	7	10	21	13
Number of cows	178	232	495	369.5
Cows per farm	25.4	23.2	23.6	28.4
Pounds of milk produced per cow	4,069	5,412	6,455	7,842
Per cent of cows freshening from September to December, inclusive	44.3	33.6	51.0	52.8
Cost of milk per 100 pounds sold	$2.92	$3.07	$2.97	$2.45
Average labor income	+$558	-$241	+$1,198	+$2,126
Cost of raising a heifer to two years of age	$110.93	$100.55	$122.84	$143.65

production, whether for land, animals, or operator, are as important as the volume of business. Good production per cow results from many things, such as large and good cows, proper feeding and care, fall freshening, a large proportion of mature cows, a small number of abnormal calvings, and the like. A comparison of the five herds in each area getting the highest yield per cow with the five getting the lowest yield per cow, with reference to some of these points, is given in table 79. A very great difference in labor income, amounting to over $100 a month, is shown.

TABLE 79. RELATION OF PRODUCTION PER COW TO VARIOUS FACTORS

	Oxford farms without cash crops		Tully and Homer farms with cash crops	
	Averages of		Averages of	
	Five farms with highest production per cow	Five farms with lowest production per cow	Five farms with highest production per cow	Five farms with lowest production per cow
Number of cows	21.1	28.5	23.0	25.6
Pounds of milk produced per cow	8,988	3,655	8,402	3,903
Per cent of cows replaced during year	28.9	30.3	20.7	46.7
Per cent of cows from 5 to 8 years of age	45.1	57.7	52.2	36.4
Per cent of abnormal calvings	12.0	9.5	1.2	11.8
Per cent of cows freshening from September to December, inclusive	49.9	29.0	56.9	47.7
Pounds of feed used per cow:				
Concentrates	2,670	1,145	2,812	1,040
Succulent feed	9,326	5,084	13,753	9,691
Dry forage	6,069	5,631	2,733	2,191
Cow cost of milk per 100 pounds	$2.71	$3.76	$2.47	$2.98
Crop sales per farm	$78	$75	$1,402	$1,819
Labor income	+$167	-$1,119	+$1,919	+$365

FERTILITY MAINTENANCE

Ordinarily the production of cash crops without the dairy in regions such as those described here is not successful. An exclusive crop business requires almost as large an acreage of crop land as that in the entire farm, to furnish as much income as the system followed on these farms. Also, while it may be possible to maintain yields without the return of manure, it is seldom accomplished by those who substitute crop farming for the dairy. When this is done, yields of all crops, corn, potatoes, cabbage, oats, and hay, decrease perceptibly. In dairy regions, the intensive dairymen are commonly more prosperous than the crop farmers.

The use of fertilizers and lime is summarized in tables 80 and 81. Of the fertilizer used on the Oxford farms, 56.4 per cent was acid phosphate, 10.4 per cent was 2–8–2, 5.4 per cent was 2–8–6, and the remaining 27.8 per cent was of various other mixed brands. A total of 279 tons of lime, mostly ground limestone, was used on these farms; the average was 3.3 tons per farm.

Of the fertilizer used on the Tully and Homer farms, 33.4 per cent was acid phosphate, 19 per cent was 2–8–10, 7.6 per cent was 2–8–2, and the remaining 40 per cent was of various other mixed brands. The high-analysis fertilizers were used chiefly on cabbage and potatoes.

The kinds of fertilizer most commonly used for the potato crop were acid phosphate, 2–8–7, and 2–8–2. The kinds most commonly used on cabbage were acid phosphate and 2–8–10. The average rate of application of commercial fertilizer to potatoes on the Oxford farms was 606 pounds per acre, and on the Tully and Homer farms 523 pounds per acre. On the Tully and Homer farms, the average rate of application of commercial fertilizer to 166 acres of cabbage was 613 pounds per acre. Lime, consisting mostly of ground limestone, was used on 87.5 acres of cabbage on 22 farms. The average rate of application was 2223 pounds per acre.

On the Oxford farms, 30.9 per cent of the manure was used for the corn crop, 28.8 per cent on new seedings, 35.3 per cent on old meadows, and the remaining 5 per cent on miscellaneous crops (table 82). On the Tully and Homer farms, 42.5 per cent was used for the corn crop, 21.4 per cent on new seedings, 8.3 per cent on old meadows, 6.6 per cent on alfalfa, 19.2 per cent on cabbage and potatoes, and the remaining 2.0 per cent on miscellaneous crops. On the latter farms only a trifle over one-third of the manure, and on the Oxford farms two-thirds, was used for meadows. Considering that the soil types and the climate of the Oxford farms were less favorable for hay than those of the other farms, the yields of hay were better on the Oxford farms. Top-dressing of meadows has much influence in obtaining good yields of hay. Such top-dressing results also in a heavier sod to be plowed under later for cultivated crops.

The average rate of spreading of manure for all crops was 10.8 tons per acre for the Oxford farms, and 12.6 tons for the Tully and Homer farms. The rate was 14.2 tons for corn for the silo, 11.7 tons on new seedings, and 8.5 tons on old meadows, for the Oxford group, and 14.6 tons for corn for the silo, 10.3 tons on new seedings, 11.3 tons on old meadows, 15.7 tons for potatoes, and 14.2 tons for cabbage, on the Tully and Homer farms.

TABLE 80. SUMMARY OF USE OF FERTILIZER AND LIME ON 135 FARMS

Forms of fertilizer and lime	84 Oxford farms					51 Tully and Homer farms				
	Number of farms using	Acres fertilized	Total pounds used	Pounds used per acre fertilized	Cost of fertilizer	Number of farms using	Acres fertilized	Total pounds used	Pounds used per acre fertilized	Cost of fertilizer
For corn for silo:										
Sodium nitrate	2	4	1,734	434	$ 68	1	12.0	500	42	$ 15
Acid phosphate	15	110	42,998	391	619	13	135.0	32,500	241	390
Purchased hen manure	1	1	500	500	18	......	......	......	......	......
0-10- 2	1	2	1,250	625	24	......	......	......	......	......
1- 8- 2	......	......	......	......	......	1	10.0	2,000	200	45
1- 8- 4	1	10	2,000	200	36	2	27.5	4,805	175	70
2- 8- 0	1	10	2,000	200	17	1	9.0	4,100	456	64
2- 8- 2	3	15	4,500	300	95	5	48.0	11,913	248	217
2- 8- 3	1	3	400	133	8	2	13.0	4,833	372	102
2- 8- 4	4	12	4,341	362	94	2	17.0	4,501	265	93
2- 8- 6	2	14	5,000	357	120	3	29.0	9,268	320	208
2- 8-10	......	......	......	......	......	9	84.5	25,030	296	599
2-10- 5	1	4	1,200	300	18	......	......	......	......	......
2-12- 2	1	10	2,000	200	45	......	......	......	......	......
3- 8- 4	......	......	......	......	......	1	10.0	500	50	20
3- 8- 6	......	......	......	......	......	1	6.0	1,200	200	27
4- 8- 4	......	......	......	......	......	1	11.0	7,703	700	154
4- 8-10	......	......	......	......	......	1	10.0	4,000	400	70
Total fertilizer	......	195	67,923	348	$1,162	......	422.0	112,853	267	$2,074
Ground limestone	5	31	39,216	1,265	$120	1	8	16,000	2,000	$33
For corn for silo, surplus:										
Acid phosphate	3	6	1,678	280	$25	......	......	......	......	......
2-8-2	......	......	......	......	......	1	1	144	144	$ 2
2-8-3	1	1	100	100	2	......	......	......	......	......
2-8-4	......	......	......	......	......	2	3	699	233	15
2-8-6	......	......	......	......	......	1	3	900	300	22
Total fertilizer	......	7	1,778	254	$27	......	7	1,743	249	$39
Ground limestone	1	2	1,540	770	$5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

For corn fed green:										
Acid phosphate	1	1	500	500	$ 7	...	...	...	...	...
0–10–2	1	2	1,250	625	23	...	...	...	...	...
1– 8–4	...	...	...	...	...	1	1.5	195	130	$ 3
2– 8–2	...	...	...	...	...	1	1.0	142	142	2
2– 8–3	...	...	...	...	...	1	1.0	167	167	4
2– 8–4	...	...	...	...	...	1	1.0	200	200	4
2– 8–6	...	...	...	...	...	1	3.0	616	205	12
4– 8–4	...	...	...	...	...	1	1.0	697	697	14
Total	...	3	1,750	583	$30	...	8.5	2,017	237	$39
For corn for grain:										
Acid phosphate	2	4	214	54	$19	3	7	1,550	221	$16
2–8– 2	...	...	...	...	...	2	7	1,701	243	31
2–8– 3	...	...	...	...	...	1	2	1,000	500	21
2–8– 4	...	...	...	...	...	1	2	400	200	9
2–8– 6	...	...	...	...	...	1	3	616	205	12
2–8–10	...	...	...	...	...	1	2	220	110	5
Total	...	4	214	54	$19	...	23	5,487	239	$94
Ground limestone	1	1	769	769	$2	...	...	...	...	...
For corn fodder:										
Acid phosphate	1	2	600	300	$ 12	1	4	2,400	600	$25
1–8– 2	1	3	670	223	11	...	...	...	...	...
2–8– 2	2	6	1,700	283	35	...	...	...	...	...
2–8–10	...	...	...	...	...	2	9	3,000	333	58
Total	...	11	2,970	270	$58	...	13	5,400	415	$83
For oats:										
Acid phosphate	9	60	20,550	342	$279	17	248.5	50,950	205	$667
Bone meal	...	...	...	...	...	1	14.0	5,600	400	98
0–10– 2	...	...	...	...	...	2	21.0	4,100	195	67
1– 8– 2	3	13	3,430	264	55	...	...	...	...	...
1– 8– 3	...	...	...	...	...	1	55.0	11,000	200	220
1– 8– 4	1	20	4,000	200	72	1	23.0	11,500	500	154
2– 8– 2	1	9	1,000	111	21	4	94.0	11,800	126	248
2– 8– 3	...	...	...	...	...	1	15.0	3,000	200	36

TABLE 80 (*continued*)

Forms of fertilizer and lime	84 Oxford farms: Number of farms using	Acres fertilized	Total pounds used	Pounds used per acre fertilized	Cost of fertilizer	51 Tully and Homer farms: Number of farms using	Acres fertilized	Pounds used	Pounds used per acre fertilized	Cost of fertilizer
For oats (*concluded*):										
2- 8- 4	1	4	588	147	$12	1	16.0	4,800	300	$ 74
2- 8- 6	1	3	450	150	10	1	15.0	2,250	150	56
2- 8-10	....	....	....	....	....	5	73.0	11,100	152	234
2-10- 5	1	6	1,800	300	27	....	....	....	....	....
2-12- 2	1	5	2,000	400	40	....	....	....	....	....
4- 8-10	....	....	....	....	....	1	18.0	4,000	222	70
Total fertilizer	....	120	33,818	282	$516	....	592.5	120,100	203	$1,924
Hydrated lime	2	17	10,400	612	$66	2	30	11,000	367	$118
Ground limestone	28	181	312,249	1,725	$906	16	177	302,000	1,706	$779
For oats and barley:										
Acid phosphate	....	....	....	....	....	2	16	3,200	200	$37
1-8- 2	....	....	....	....	....	1	12	2,300	192	52
1-8- 3	....	....	....	....	....	1	12	1,800	150	39
2-8-10	....	....	....	....	....	1	8	2,000	250	33
4-8- 7	....	....	....	....	....	1	18	3,000	167	81
Total	....	....	....	....	....	....	66	12,300	186	$242
Ground limestone	....	....	....	....	....	1	18	8,000	444	$20
For oats and peas:										
Sodium nitrate	1	10	1,670	167	$58	....	....	....	....	....
Acid phosphate	1	10	5,000	500	70	1	2	600	300	$7
2-8-6	1	6	900	150	20	....	....	....	....	....
Total	....	26	7,570	291	$148	....	2	600	300	$7
Ground limestone	3	12	31,000	2,583	$97	....	....	....	....	....
For oats and peas, 1922:										
Ground limestone	1	12	50,000	4,167	$101	....	....	....	....	....

For barley:										
Acid phosphate	....	....	....	....	....	1	4	800	200	$11
2–8–6	....	....	....	....	....	1	5	750	150	19
2–8–10	....	....	....	....	....	1	13	2,600	200	65
Total	....	....	....	....	....	....	22	4,150	189	$95
Hydrated lime	....	....	....	....	....	1	4	8,000	2,000	$60
For buckwheat:										
Acid phosphate	....	....	....	....	....	1	3	900	300	$10
1–8–2	2	4	1,200	300	$16	....	....	....	....	....
1–8–3	....	....	....	....	....	1	10	2,000	200	40
Total	....	4	1,200	300	$16	....	13	2,900	223	$50
For wheat:										
Acid phosphate	2	7	1,600	229	$21	1	5	1,250	250	$16
1–8–3	....	....	....	....	....	1	2	200	100	4
2–8–6	....	....	....	....	....	1	17	3,500	206	70
Total	....	7	1,600	229	$21	....	24	4,950	206	$90
Ground limestone	1	8	24,000	3,000	$86	1	2	6,000	3,000	$24
For peas for the cannery:										
Acid phosphate	....	....	....	....	....	2	6	2,700	450	$33
2–8–2	....	....	....	....	....	1	4	400	100	7
2–8–4	....	....	....	....	....	1	4	1,200	300	24
Total	....	....	....	....	....	....	14	4,300	307	$64
Ground limestone	....	....	....	....	....	1	3	6,000	2,000	$12
For oats, peas, and barley:										
Acid phosphate	....	....	....	....	....	2	21	5,800	276	$72
Total	....	....	....	....	....	....	21	5,800	276	$72
For hay:										
Purchased hen manure	1	1	500	500	$18	....	....	....	....	....
Total	....	1	500	500	$18	....	....	....	....	....
Hydrated lime	1	22	16,000	727	$108	....	....	....	....	....
Ground limestone	5	36	71,231	1,979	$205	2	55	95,000	1,727	$129

Forms of fertilizer and lime	Number of farms using	Acres fertilized	Total pounds used	Pounds used per acre fertilized	Cost of fertilizer	Number of farms using	Acres fertilized	Total pounds used	Pounds used per acre fertilized	Cost of fertilizer
For oat hay:										
0-10-2	....	....	....	....	....	1	6	2,000	333	$32
2- 8-7	....	....	....	....	....	1	2	600	300	17
Total	....	....	....	....	....	....	8	2,600	325	$49
Ground limestone	....	....	....	....	....	1	8	24,000	3,000	$48
For alfalfa:										
Hydrated lime	....	....	....	....	....	1	9	20,000	2,222	$112
Ground limestone	1	0.5	2,000	4,000	$5	1	8	16,000	2,000	$50
For millet:										
Acid phosphate	....	....	....	....	....	1	2	500	300	$15
1-8-2	1	1	300	300	$5	....	....	....	....	....
2-8-2	....	....	....	....	....	1	2	600	250	7
Total	....	1	300	300	$5	....	4	1,100	275	$22
For potatoes:										
Acid phosphate	3	4.0	1,660	415	$ 24	11	38.3	22,660	592	$258
Potash (from 40 to 45 per cent)	....	....	....	....	....	1	5.0	400	80	15
1-8- 2	1	0.8	500	625	7	....	....	....	....	....
2-8- 0	....	....	....	....	....	1	1.0	400	400	6
2-8- 2	5	7.5	5,800	773	106	5	13.0	5,800	446	105
2-8- 3	....	....	....	....	....	1	12.0	6,000	500	126
2-8- 4	2	1.5	321	214	8	3	17.0	4,000	235	85
2-8- 6	3	1.5	900	600	27	2	13.0	7,500	577	179
2-8- 7	....	....	....	....	....	3	6.0	5,400	900	158

2-8-10	1	1.0	500	500	13	11	50.5	22,200	440	526
2-8-16						1	5.0	1,000	200	42
3-8- 6						1	3.0	800	267	18
3-8-10						1	3.0	2,000	667	50
4-8- 2	1	0.8	500	62	13					
4-8- 4	1	3.0	2,000	667	70	4	18.5	19,900	1,076	431
4-8-10						1	10.0	4,000	400	70
Total		20.1	12,181	606	$268		195.3	102,060	523	$2,069
For cabbage:										
Acid phosphate						15	58.5	37,700	644	$471
Bone meal						1	5.0	5,000	1,000	87
0-10- 2						2	5.0	3,900	780	62
2- 8- 0						1	5.0	5,500	1,100	85
2- 8- 2	1	0.5	1,000	2,000	$15	2	8.0	4,800	600	87
2- 8- 3						1	10.0	5,000	500	105
2- 8- 4						1	5.0	2,500	500	54
2- 8- 6						2	8.0	3,600	450	87
2- 8-10						10	50.0	27,200	544	659
3- 8- 4						1	1.0	500	500	20
4- 8- 4						3	7.5	4,000	533	98
4- 8-10						1	3.0	2,000	667	35
Total		0.5	1,000	2,000	$15		166.0	101,700	613	$1,850
Hydrated lime						3	12.5	17,000	1,360	$142
Ground limestone						19	75	177,500	2,367	$441
Held over:										
Acid phosphate	1		1,000		$18					
2-8-10	1		500		13					
Total			1,500		$31					

TABLE 81. SUMMARY OF FERTILIZER AND LIME USED ON 135 FARMS

Forms of fertilizer and lime	84 Oxford farms		51 Tully and Homer farms	
	Pounds used	Per cent of total	Pounds used	Per cent of total
Sodium nitrate	3,404	2.5	500	0.1
Acid phosphate	75,800	56.4	163,510	33.4
Potash, from 40 to 45 per cent	....	......	400	0.1
Bone meal	....	......	10,600	2.2
Purchased hen manure	1,000	0.7	....	....
0-10-2	2,500	1.9	10,000	2.0
1-8-2	6,100	4.5	4,300	0.9
1-8-3	....	......	15,000	3.1
1-8-4	6,000	4.5	16,500	3.4
2-8-0	2,000	1.5	10,000	2.0
2-8-2	14,000	10.4	37,300	7.6
2-8-3	500	0.4	20,000	4.1
2-8-4	5,250	3.9	18,300	3.7
2-8-6	7,250	5.4	29,000	5.9
2-8-7	....	......	6,000	1.2
2-8-10	1,000	0.8	93,350	19.0
2-8-16	....	......	1,000	0.2
2-10-5	3,000	2.2	....	....
2-12-2	4,000	3.0	....	....
3-8-4	....	......	1,000	0.2
3-8-6	....	......	2,000	0.4
3-8-10	....	......	2,000	0.4
4-8-2	500	0.4	....	....
4-8-4	2,000	1.5	32,300	6.6
4-8-7	....	......	3,000	0.6
4-8-10	....	......	14,000	2.9
Total*	134,304	100.0	490,060	100.0
Ground limestone	532,005	......	650,500	....
Hydrated lime	26,400	......	56,000	....

* Including 1000 pounds of acid phosphate, $18, and 500 pounds of 2-8-10, $13, held over, and ½ ton of purchased hen manure.

The use of sod land for corn, well manured and plowed in the spring so that a few inches of green grass and the manure are turned under together, gives the crop a quicker start and a more rapid growth early in the season than does stubble land. The difference at the end of the season is not so great, altho the yield on sod land is usually better, especially under valley conditions where the land is low, for then the ample supply of moisture aids the decomposition of the manure and grass that have been turned under.

The removal from, and return of, plant food to the soil was computed under the conditions set forth in Bulletin 421 of this experiment station.[9] It is apparent from table 83 that the nitrogen and phosphorus balance is maintained but that the potash is being depleted. The Tully and Homer farms having cash crops in the system used more commercial

[9]Economic studies of dairy farming in New York. I. Condensery milk without cash crops. By E. G. Misner. Cornell Univ. Agr. Exp. Sta., Bul 421, 1923, p. 66.

fertilizer and lime than the Oxford farms, and therefore the phosphorus and lime balances were more fully maintained. Also, they having more alfalfa, clover, and peas — leguminous crops — and using more manure than the Oxford farms, the nitrogen balance was more completely maintained.

TABLE 82. SUMMARY OF USE OF MANURE ON 135 FARMS

	Number of farms using	Acres manured	Tons applied	Tons per acre manured	Per cent of tons applied
	84 Oxford farms				
Corn for grain	11	30	463	15.4	2.3
Corn fodder	19	36.5	475	13.0	2.3
Corn for silo	56	375	5,340	14.2	26.3
Oats	5	14	125	8.9	0.6
Oats and peas	3	21	158	7.5	0.8
Barley	1	5	68	13.6	0.3
Buckwheat	1	3	60	20.0	0.3
Wheat	1	1	12	12.0	0.1
Oat hay	1	5	30	6.0	0.1
Hay (first year)	69	500.5	5,847	11.7	28.8
Hay (old meadows)	67	844.8	7,162	8.5	35.3
Alfalfa	2	3.5	34	9.7	0.2
Millet	2	5	90	18.0	0.4
Potatoes	21	31.3	409	13.1	2.0
Cabbage	1	0.5	10	20.0	0.1
Garden	1	....	10	....	0.1
Total	......	1,876.1	20,293	10.8	100.0
	51 Tully and Homer farms				
Corn for grain	4	9	137	15.2	1.0
Corn fodder	8	18	274	15.2	2.0
Corn for silo	43	379	5,529	14.6	39.5
Oats	2	16	147	9.2	1.0
Oats and barley	1	12	67	5.6	0.5
Oats and peas	1	2	30	15.0	0.2
Buckwheat	1	2	13	6.5	0.1
Hay (first year)	29	290	2,998	10.3	21.4
Hay (old meadows)	11	103	1,164	11.3	8.3
Alfalfa	10	93	927	10.0	6.6
Millet	1	2	24	12.0	0.2
Potatoes	19	68.5	1,076	15.7	7.7
Cabbage	29	113.5	1,615	14.2	11.5
Total	......	1,108.0	14,001	12.6	100.0
Not used	......	....	50	....	....

According to the fertilizer-balance computation shown in table 83, on the Oxford farms about 4 pounds more of nitrogen was added per acre per year than was removed by the crops, 3 pounds more of phosphoric acid, and 58 pounds more of lime, but 19 pounds less of potash. On the Tully and Homer farms, there was approximately 6 pounds more of

nitrogen, 9 pounds more of phosphoric acid, 112 pounds more of lime, and 25 pounds less of potash, added each year than was removed by the crops.

TABLE 83. FERTILITY BALANCE STATEMENT FOR 135 FARMS

	Pounds of plant food				Tons of organic matter
	N	P_2O_5	K_2O	CaO	
	84 Oxford farms (5300.6 acres, excluding orchard)				
By removal in crops grown (total)	212,734	74,761	276,779	94,149	....
By removal per acre of crops, excluding orchard	40	14	52	18	....
By addition:					
Nodule fixation*	40,569	....	....	....	....
Commercial fertilizer	1,317	16,731	1,727	22,993	....
Lime	....	....	....	316,931	....
Seed	1,222	494	578	63	30.5
Straw, hay, etc. for bedding	3,663	1,421	9,004	2,366	253.6
Dry forage fed†	91,477	33,288	122,079	39,256	2,385.6
Succulent feed fed†	25,951	14,028	32,590	14,488	729.3
Concentrates fed†	69,637	21,717	10,993	4,837	829.4
Total amount added	233,836	87,679	176,971	400,934	4,228.4
Amount added per acre	44	17	33	76	0.80
Removal less addition per acre	+4	+3	—19	+58	....
	51 Tully and Homer farms (3777.4 acres, excluding orchard)				
By removal in crops grown (total)	207,458	70,697	242,625	107,953	....
By removal per acre of crops, excluding orchard	55	19	64	29	....
By addition:					
Nodule fixation*	75,992	....	....	....	....
Commercial fertilizer	6,692	53,262	20,149	71,457	....
Lime	....	....	....	404,600	....
Seed	2,323	867	1,361	102	55.1
Straw, hay, etc., for bedding	7,275	2,570	18,071	5,091	559.1
Dry forage fed†	56,226	18,120	67,010	33,763	1,278.3
Succulent feed fed†	26,036	13,991	32,701	14,492	732.6
Concentrates fed†	54,975	17,892	9,677	4,066	640.0
Total amount added	229,519	106,702	148,969	533,571	3,265.1
Amount added per acre	61	28	39	141	0.86
Removal less addition per acre	+6	+9	—25	+112	....

* Two-thirds of the nitrogen used for oats and peas considered as coming from leguminous part of peas.
† When it is considered that 60 per cent of the N, 70 per cent of the P_2O_5, 60 per cent of the K_2O, 60 per cent of the CaO, and 45 per cent of the dry matter, in feed, is returned in manure.

If Van Slyke's composition of fresh manure is taken, then the proportion of the elements in the winter feed returned in the manure would be as shown in table 84:

TABLE 84. PERCENTAGE OF ELEMENTS AND ORGANIC MATTER IN BARN FEED RECOVERED IN MANURE

	Oxford	Tully and Homer
Nitrogen	78.5	72.2
Phosphoric acid	65.2	60.7
Potash	64.6	61.5
Organic matter	31.7	26.4

LABOR DISTRIBUTION

The amount of labor actually spent on cattle, as determined by the survey, was added to the amount of labor spent on crops, as determined by applying work units to the acres of crops grown. This was distributed by months according to data from cost accounts obtained by the New York State College of Agriculture. For the Oxford farms 75.1 per cent, and for the Tully and Homer farms 63.5 per cent, of the work was spent on cattle. A larger proportion of the amount of labor for the latter area was spent on cultivated crops.

The percentage of the labor in each month devoted to cattle ranged from 44.3 per cent in July to 84.5 per cent in December, January, and March for the Oxford farms, and from 40.9 per cent in July to 82.3 per cent in January for the Tully and Homer farms. From March to November, in particular, the percentage of labor on cattle was much less for the latter farms because of the larger amount of work on crops, especially on the cash crops (table 85).

The productive work units, excluding work for horses, averaged 241 per man for the Oxford farms and 270 per man, or 12 per cent higher, for the Tully and Homer farms. This difference emphasizes the greater labor accomplishment per man under a system which combines cash crops with the dairy enterprise.

The schedule of labor on the typical dairy farm of this area with cash crops is approximately as follows:

For the entire year, milking.

From January to March, cutting wood and harvesting ice.

From March to April, making sirup, plowing, planting cannery peas and oats.

May, making cabbage seedbed, planting corn and potatoes.

June, cultivating, setting cabbage, and harvesting first cuttings of hay.

July, cultivating cabbage, spraying potatoes, and haying.

August, harvesting oats and second cuttings, and cultivating cabbage.

September, filling silo, digging potatoes, and harvesting second or third cuttings of hay.

October, digging potatoes and harvesting cabbage.

November, harvesting cabbage, plowing.

December, cutting wood, working in barn.

TABLE 85. SUMMARY OF WORK UNITS ON 135 FARMS

	Cattle	Other live-stock	Culti-vated crops	Grain crops and annual hay crops	Hay	Other crops	Miscel-laneous	Total	Per cent on cattle	Per cent for each month
	84 Oxford farms									
January	3,346	384	27	7	85	3	110	3,962	84.5	8.2
February	3,045	372	26	1	94	3	110	3,651	83.4	7.6
March	3,280	398	20	5	73	10	96	3,882	84.5	8.1
April	3,112	421	117	224	106	17	281	4,278	72.7	8.9
May	2,844	418	517	184	68	10	27	4,068	69.9	8.5
June	2,343	373	656	36	180	5	27	3,620	64.7	7.5
July	2,276	355	417	31	2,025	3	27	5,134	44.3	10.7
August	2,209	343	148	420	1,020	6	63	4,209	52.5	8.8
September	2,209	320	510	253	232	18	7	3,549	62.2	7.4
October	2,543	338	1,045	95	44	54	7	4,126	61.6	8.6
November	2,911	349	224	65	32	9	27	3,617	80.5	7.5
December	3,346	381	58	22	96	2	53	3,958	84.5	8.2
Total including labor on horses	33,464	4,452	3,765	1,343	4,055	140	835	48,054	....	100.0
Total not including labor on horses	33,464	942	3,765	1,343	4,055	140	835	44,544	....	.....
Per cent	75.1	2.1	8.5	3.0	9.1	0.3	1.9	100.0	....	.....
	51 Tully and Homer farms									
January	2,208	282	118	10	37	3	26	2,684	82.3	7.1
February	2,009	267	101	2	40	4	29	2,452	81.9	6.5
March	2,164	297	91	9	32	12	214	2,819	76.8	7.5
April	2,054	324	209	335	51	19	414	3,406	60.3	9.0
May	1,877	322	797	269	41	73	80	3,459	54.3	9.2
June	1,546	288	1,236	49	195	59	....	3,373	45.8	9.0
July	1,501	272	931	109	855	3	....	3,671	40.9	9.8
August	1,457	263	331	614	817	7	23	3,512	41.5	9.3

September	1,457	248	594	367	196	20	....	2,882	50.6	7.7
October	1,678	257	1,413	120	32	60	...	3,560	47.1	9.5
November	1,921	260	791	88	14	10	....	3,084	62.3	8.2
December	2,208	279	112	35	64	2	14	2,714	81.4	7.2
Total including labor on horses	22,080	3,359	6,724	2,007	2,374	272	800	37,616	....	100.0
Total not including labor on horses	22,080	521	6,724	2,007	2,374	272	800	34,778	....	.....
Per cent	63.5	1.5	19.3	5.8	6.8	0.8	2.3	100.0	....	....

The most critical periods in this order of work are in May, July, and September.

In more than half of May there is as much barn work on the dairy farm as in winter. With the large number of animals per farm, only about half the time can be found for field work. It is too early in the spring for the children to be out of school. This means that, with only the regular help, the tasks of completing the plowing, fitting the land, and planting the corn and potatoes, make it difficult to get the work done on

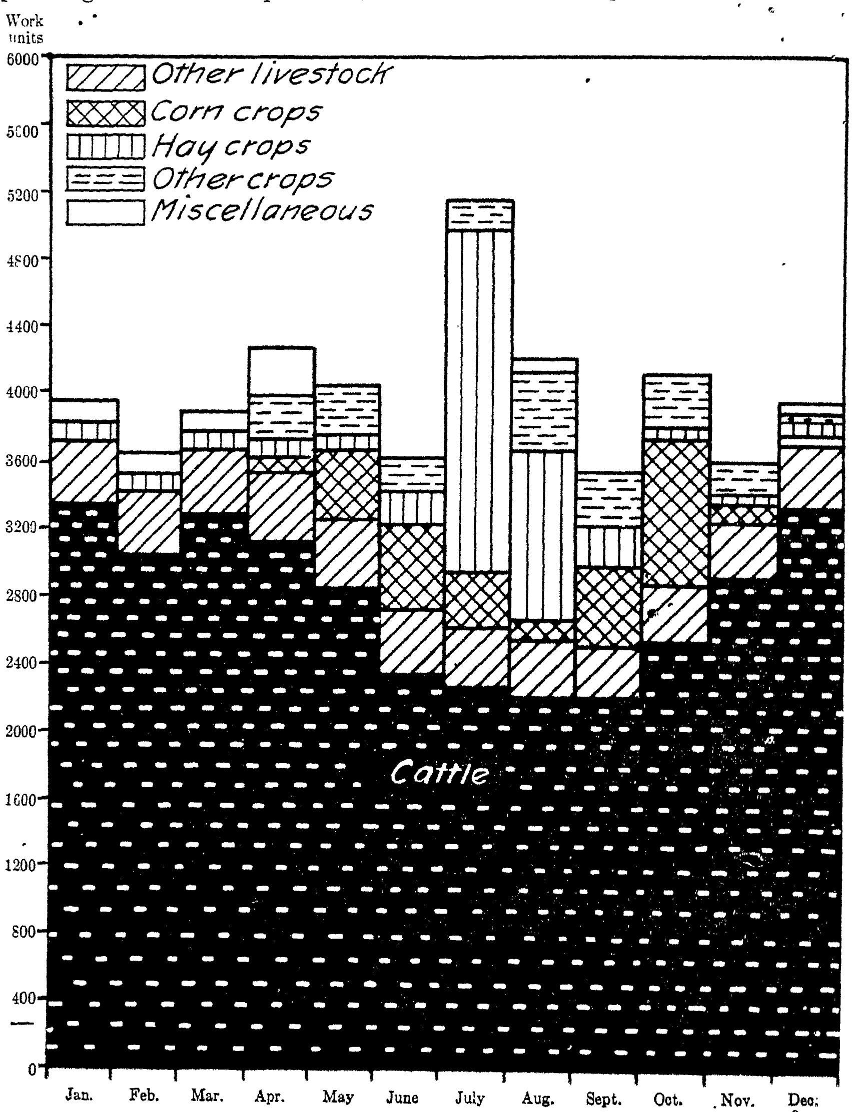

FIGURE 17. DISTRIBUTION OF MAN LABOR ON 84 OXFORD FARMS

time. As a result, planting of the silo corn is frequently too late, as this crop should be planted early in an ordinary season to reach the glazing stage.

During the last of June, the new seedings should be cut to allow for a good second crop being harvested early enough so that growth will start before cold weather. At the same time the cabbage is to be set. By the first of July, the peas are ready, cultivation and hoeing is on, and haying is pressing. A very acute demand for labor results, and since this need

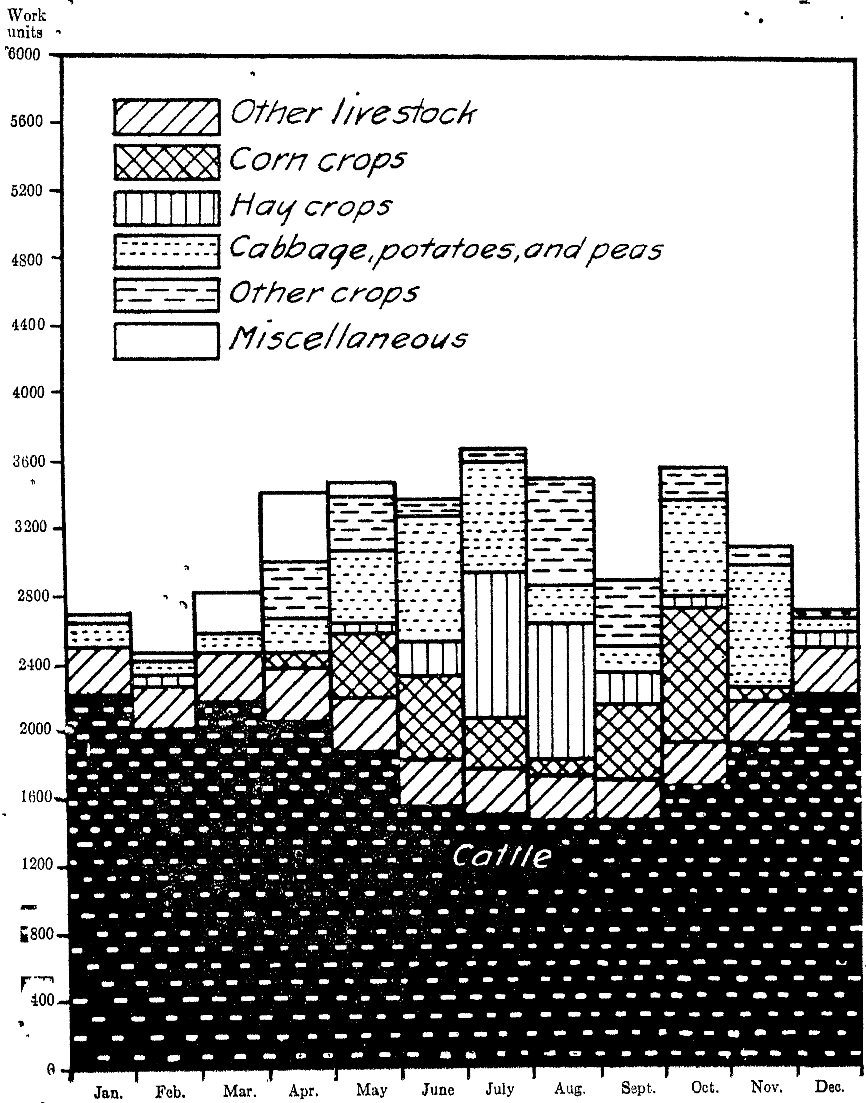

FIGURE 18. DISTRIBUTION OF MAN LABOR ON 51 TULLY AND HOMER FARMS

comes at the same time on all farms, making exchange of labor of little advantage, the hay is commonly harvested much beyond its prime.

In September the harvesting of a large amount of silage corn creates plenty of heavy work, and as on many farms cows are beginning to freshen at this season, they are sometimes neglected.

There are few types of farming that provide as full a labor schedule and as good a distribution of labor as Grade A dairying with the intensive cultivated cash crops. If plenty of crop land were available, wheat might be advantageously added to the system, as it could be drilled before silo filling and harvested after the July rush. A poultry enterprise of 500 to 800 hens completes a well-organized business and can be readily handled with the Grade A milk and cash crops, especially if the flock is maintained by purchase.

CROPPING SYSTEM AND ROTATION

The acreage devoted to growing crops for home-farm use was 98.2 per cent of the total crop area on the Oxford farms. This was land devoted chiefly to feed for cattle, and for the horses used in growing feed for cattle. The crops kept at home represented 95.7 per cent of the work units. On the Tully and Homer farms, 83.1 per cent of the crop area was used for crops kept at home, and 16.9 per cent was used for crops sold. In this group of farms, the home crops required 65.5 per cent, or two-thirds, of the man labor, one-third of the labor efforts of the farms going into crops sold.

Of the crop area on the Oxford farms, 12.7 per cent was in cultivated crops, 12.3 per cent in grain and annual hay crops, 74.1 per cent in hay, and 0.9 per cent in miscellaneous crops (table 86). On the Tully and Homer farms, 24.8 per cent was in cultivated crops, 25.4 per cent in grain and annual hay crops, 48.1 per cent in hay, and 1.7 per cent in other crops. From this it appears that the rotation in the Oxford farms was one year of cultivated crops, one year of nurse crops for seeding, and

TABLE 86. ACREAGE AND APPROXIMATE LABOR DEVOTED TO CROPS FOR HOME-FARM USE, AND TO CROPS FOR MARKET

	84 Oxford farms				51 Tully and Homer farms			
	Acres	Per cent	Man-work units	Per cent	Acres	Per cent	Man-work units	Per cent
Cultivated crops chiefly for cattle or horse feed, or for home use	649.6	12.1	3,445	37.0	614.1	16.0	3,352	29.5
Cultivated crops chiefly for sale	34.5	0.6	320	3.5	337.8	8.8	3,372	29.6
Grain crops and annual hay crops chiefly for home-farm use	644.6	12.1	1,325	14.2	869.0	22.6	1,751	15.4
Grain crops chiefly for sale	8.9	0.2	18	0.2	109.5	2.8	256	2.3
Hay for home-farm use	3,910.2	73.1	3,910	42.0	1,642.8	42.8	1,643	14.4
Hay for home-farm use (second cutting)*	(92)	.....	92	1.0	(436.1)	......	436	3.8
Hay for sale	52.8	1.0	53	0.6	204.2	5.3	204	1.8
Hay for sale (second cutting)*	......	......	......	......	(90.9)	.....	91	0.8
Other crops chiefly for home-farm use	46.5	0.9	140	1.5	64.3	1.7	272	2.4
Total	5,347.1	100.0	9,393	100.0	3,841.7	100.0	11,377	100.0

* Figures for second cuttings are not included in the total crop area.

about six years of hay; for the other farms, one year of cultivated crops, one year of nurse or seeding crops, and two years of hay. The land is plowed more frequently in the latter area, but, due probably to the fact that the fields are left continuously in meadow in the Oxford area, the length of the rotation for those farms is somewhat reduced.

The acres of crops averaged 28.9 per man for the Oxford farms and 29.8 for the Tully and Homer farms, the animal units per man 15.5 for the former group and 13.6 for the latter, and the returns for labor, after all operating expenses except labor and 5 per-cent interest on the capital are deducted from the receipts, $496 per man for the Oxford farms and $931 per man for the Tully and Homer farms.

The average number of animal units per farm was 34.0 for the Oxford farms and 34.4 for the other farms. The acres of crops per animal unit were 1.9 and 2.2, respectively. For the Oxford group, then, there were 3.8 tons of manure used annually per acre of crop land, and for the Tully and Homer group 3.7 tons. The first group of farms purchased 43 cents worth of commercial fertilizer per acre of crops, and the latter $2.31 worth.

SUMMARY OF AVERAGES

It is not considered necessary to summarize here all the relationships shown thruout this bulletin. The most important business-analysis averages for the Oxford and for the Tully and Homer farms are brought together in table 87. A comparison of some of the more important averages for the Tully farms with those of the Homer farms is given in table 88. A most conspicuous difference in these averages indicates that the system of farming is more intensive thruout at Homer, twice as many animals being kept per acre of crop land in that area as in the vicinity of Tully, and the crop sales per farm being as high as in Tully.

A report of the more important business factors for the farms studied in both areas is given in tables 89 and 90.

TABLE 87. SUMMARY OF AVERAGES BY AREAS

	Average for 84 Oxford farms	Average for 51 Tully and Homer farms
Year of record, ending April 30	1922	1922
County	Chenango	Onondaga and Cortland
Labor income	+$299	+$1,065
Labor income if pool prices had been received	+$222	+$602
Size of business:		
1. Productive man-work units	530	682
2. Acres of crops	63.6	75.3
3. Acres pastured (woods expressed in equivalent of open pasture)	89.4	69.6
4. Number of cows, average	25	25
5. Number of men, including operator	2.2	2.53
6. Capital	$13,040	$19,204
7. Hundredweight of milk sold per farm	1,355	1,516
8. Animal units per farm:		
Including work animals	34.0	34.4
Excluding work animals	30.5	29.8

TABLE 87 (*continued*)

	Average for 84 Oxford farms	Average for 51 Tully and Homer farms
Year of record, ending April 30	1922	1922
County	Chenango	Onondaga and Cortland
Type of business:		
9. Average miles to milk station	3.0	3.1
10. Per cent of total productive man-work units on:		
Cattle	75.1	63.5
Cultivated crops	8.5	19.3
Grain crops and peas	3.0	5.8
Hay	9.1	6.8
All else	4.3	4.6
11. Total productive man-work units per acre of crops	8.3	9.1
12. Per cent of capital in:		
Real estate	68	71
Livestock	21	18
Equipment and supplies	11	11
13. Per cent of cows freshening from September to December, inclusive	34.2	50.2
14. Per cent of milk sold during:		
May, June, and July	31.7	27.9
August, September, and October	22.5	20.0
November, December, and January	19.5	23.2
February, March, and April	26.3	28.9
15. Average weight of cows (pounds)	899	993
16. Average weeks cows are dry	8.4	7.6
17. Per cent of cows less than four years old	22.0	26.0
18. Per cent of cows replaced	23.1	24.0
19. Per cent of cows added that were raised at home	45.3	41.4
20. Per cent of cows added that were purchased	54.7	58.6
21. Average age of heifer when freshening for first time (months)	28.1	29.1
22. Grade of milk	Grade A	Grade A
23. Per cent of milk produced which is sold	95.3	95.8
24. Per cent of milk produced which is kept at farm	4.7	4.2
Balance of business:		
25. Pasture acres per animal unit pastured	2.9	2.4
26. Acres of crops per animal unit	1.9	2.2
27. Manure per acre of crops (tons)	3.8	3.7
28. Manure applied per acre of crops receiving manure (tons)	10.8	12.6
29. Value of purchased fertilizer per acre of crops	$0.43	$2.31
30. Labor distribution (good, fair, poor)	Fair	Good
31. Important products, and receipts from each per farm:		
Milk	$3,289	$3,966
Appreciation on cattle*	$170	$201
Crops sold	$71	$1,671
32. Constituents removed per acre by crops (pounds)		
Nitrogen	40	55
Phosphoric acid	14	19
Potash	52	64
Lime (CaO)	18	29

* Includes value of calves born during the year.

TABLE 87 (*continued*)

	Average for 84 Oxford farms	Average for 51 Tully and Homer farms
Year of record, ending April 30	1922	1922
County	Chenango	Onondaga and Cortland
Balance of business (*concluded*):		
33. Constituents added per acre (pounds):*		
Nitrogen	44	61
Phosphoric acid	17	28
Potash	33	39
Lime (CaO)	76	141
34. Per cent of receipts from crops	1.7	23.8
Rates of production:		
35. Crop index (based on average yields for New York State)	103	125
36. Crop index:		
Corn for the silo	213	223
Oats (threshed)	69	115
Hay	92	107
37. Pounds of milk produced per cow	5,724	6,337
38. Pounds of milk sold per cow	5,452	6,069
39. Pounds of milk produced per dollar invested in cows	77	68
40. Value of milk and its products sold per cow	$132	$159
41. Appreciation on cattle per cattle unit	$5.74	$6.93
Labor efficiency:		
42. Productive man-work units per man	241	270
43. Acres of crops per man	28.9	29.8
44. Animal units, except work animals, per man	13.9	11.8
45. Productive horse-work units per work animal	53	68
46. Acres of crops per work animal	18.3	16.3
47. Labor returns per man	$496	$931
48. Labor returns per man-work unit	$2.06	$3.45
49. Per cent of farms using milking machines	44	37
50. Per cent of months machines are used	70	79
51. Hundredweight of milk produced per man	647	626
Human labor:		
Hours per cow per year:		
52. Milking	63	72
53. Hauling milk	17	14
54. Other labor	72	80
Hours per 100 pounds of milk produced:		
55. Pasture season	1.8	2.0
56. Winter	3.5	3.0
57. For year	2.6	2.6
Capital efficiency:		
58. Value of crop land per acre	$37.96	$59.77
59. Value of pasture land per acre	$16.54	$25.93
60. Value of woodland per acre	$13.96	$39.65
61. Value of houses per farm	$1,671	$2,430
62. Value of cattle barns per farm	$2,048	$3,199
63. Value of other buildings per farm	$807	$1,331
64. Per cent of real-estate capital in buildings	50.7	49.9
65. Per cent of real-estate capital in land	49.3	50.1
66. Value of machinery and equipment per acre of crops	$20.08	$23.45

* No account is taken of nitrogen added by free fixation and by precipitation.

TABLE 87 (*concluded*)

	Average for 84 Oxford farms	Average for 51 Tully and Homer farms
Year of record, ending April 30	1922	1922
County	Chenango	Onondaga and Cortland
Feeding efficiency:		
Feed:		
Per cow per year:		
67. Concentrates (pounds)	1,765	2,108
68. Silage (pounds)	5,583	9,060
69. Other succulent feed (pounds)	436	1,049
70. Dry forage (pounds)	4,433	3,540
71. Protein (digestible pounds)	540	702
72. Energy (therms)	3,845	4,146
73. Days of pasture	168	154
Per cow per day during winter:		
74. Concentrates (pounds)	7.3	7.9
75. Silage (pounds)	27.1	38.8
76. Other succulent feed (pounds)	0.3	0.9
77. Dry forage (pounds)	22.4	15.6
78. Protein (digestible pounds)	2.4	2.8
79. Energy (therms)	17.8	16.7
80. Protein-energy ratio	1:7.4	1:6.1
Per 100 pounds of milk produced in pasture period:		
81. Days of pasture	6.0	6.2
82. Concentrates (pounds)	11.6	17.5
83. Silage and other succulent feed (pounds)	22.5	70.0
84. Dry forage (pounds)	0.8	10.1
Per 100 pounds of milk produced in winter period:		
85. Concentrates (pounds)	49.2	43.4
86. Silage (pounds)	182.1	212.1
87. Other succulent feed (pounds)	1.7	5.0
88. Dry forage (pounds)	150.4	85.3
89. Protein (digestible pounds)	16.2	15.1
90. Energy (therms)	119.5	91.4
Per 100 pounds of milk produced thru the year:		
91. Concentrates (pounds)	30.8	33.3
92. Silage (pounds)	97.5	143.0
93. Other succulent feed (pounds)	7.6	16.5
94. Dry forage (pounds)	77.5	55.9
95. Protein (digestible pounds)	9.4	11.1
96. Energy (therms)	67.2	65.4
Costs and returns for cows:		
97. Total costs per cow	$164	$195
98. Returns, exclusive of milk sold wholesale	$23	$25
99. Cost of milk sold per cow	$141	$170
100. Value of milk sold, cash per cow	$125	$154
101. Certificates of indebtedness, per cow	$7	$5
102. Loss per cow	$9	$11
103. Price received per 100 pounds of milk sold	$2.43	$2.62
104. Cost of producing 100 pounds of milk	$2.59	$2.79
105. Loss per 100 pounds of milk	$0.17	$0.18
Cost of raising a heifer:		
106. To two years of age	$84	$121
107. To age of freshening (approximate)	$98	$146

TABLE 88. COMPARISON OF TULLY FARMS WITH HOMER FARMS

	Averages of 29 Tully farms	Averages of 22 Homer farms
1. Labor income:		
As found	+$387	+$1,957
At pool prices	+$252	+$1,062
2. Cost of milk per 100 pounds	$2.94	$2.68
3. Price received for milk per 100 pounds	$2.39	$2.79
4. Loss per cow	$32	....
5. Gain per cow	....	$7
6. Cost of raising a heifer to two years of age	$114	$129
7. Acres of crops	84.9	62.7
8. Acres pastured (woods expressed in equivalent of open pasture)	65.5	75.0
9. Number of cows	20.0	31.5
10. Number of men, including operator	2.4	2.7
11. Capital	$16,420	$22,873
12. Hundredweight of milk sold per farm	1,159	1,987
13. Animal units per farm	29.3	41.0
14. Work animals per farm	4.6	4.7
15. Average miles to milk station	3.5	2.7
16. Per cent of capital in:		
Real estate	71	72
Livestock	17	18
Equipment and supplies	12	10
17. Per cent of cows freshening from September to December, inclusive	41.3	57.5
18. Per cent of milk sold during:		
May, June, and July	31.4	25.2
August, September, and October	20.1	19.8
November, December, and January	20.1	25.6
February, March, and April	28.4	29.4
19. Average weight of cows (pounds)	965	1,030
20. Average weeks cows are dry	7.4	8.0
21. Per cent of cows less than four years	19.2	31.6
22. Per cent of cows replaced	19.6	27.7
23. Per cent of cows added that were raised at home	59.4	31.8
24. Per cent of cows added that were purchased	40.6	68.2
25. Average age of heifer when freshening for first time (months)	29.1	29.1
26. Grade of milk	Grade A	Grade A
27. Pasture acres per animal unit pastured	2.6	2.1
28. Acres of crops per animal unit	2.9	1.5
29. Manure per acre of crops (tons)	2.7	5.4
30. Manure applied per acre of crops receiving manure (tons)	13.5	12.0
31. Value of purchased fertilizer per acre of crops	$1.54	$1.89
32. Labor distribution (good, fair, poor)	Good	Good
33. Important products, and receipts from each per farm:		
Milk	$2,774	$5,539
Appreciation on cattle	$212	$185
Crops sold	$1,641	$1,710
34. Pounds of milk produced per cow	6,133	6,507
35. Pounds of milk sold per cow	5,794	6,298
36. Butterfat test of milk (per cent)	3.56	3.44
37. Acres of crops per man	35.4	23.2
38. Acres of crops per work animal	18.5	13.3

TABLE 88 (*concluded*)

	Averages of	
	29 Tully farms	22 Homer farms
39. Per cent of farms using milking machine	28	50
40. Per cent of months machines are used	74	83
41. Hundredweight of milk produced per man	511	760
42. Pounds of concentrates per cow	1,550	2,575
43. Pounds of silage and other succulent feed per cow	10,841	9,497
44. Pounds of dry forage per cow	4,079	3,090

TABLE 89. IMPORTANT BUSINESS FACTORS FOR 84 OXFORD FARMS

(Arranged according to size of farm operated)

Farm number	Acres operated	Acres of crops	Number of cows	Average total capital	Man equiv-alent	Milk sales	Crop sales	Farm expenses	Plus labor income	Minus labor income	Cow cost of milk per hundred-weight	Pounds of milk produced per cow	Per cent of cows added by purchase
93	42	26.5	13.5	$14,606	1.1	$2,225	...	$1,595	.....	$ 220	$3.23	7,095	100.0
96	50	22.5	12.0	7,578	1.3	1,861	...	1,494	$ 345	.....	2.36	6,743	25.0
140	55	15.5	12.5	5,488	2.3	1,972	...	3,266	.....	64	3.03	5,806	0.0
88	57	27.3	11.5	6,615	2.3	1,546	$125	1,754	44	.....	2.64	5,905	0.0
108	65	29.5	22.0	16,200	2.2	2,072	39	3,066	.....	1,550	2.97	5,138	0.0
102	78	21.8	13.6	5,488	1.8	2,975	...	3,144	700	.....	3.03	8,568	0.0
164	80	26.0	11.0	6,443	1.2	1,751	105	1,068	761	.....	2.79	7,550	66.7
125	80	38.5	13.5	4,708	1.4	1,235	25	1,095	76	.....	3.41	4,595	100.0
168	81	30.0	13.0	6,426	1.3	2,095	10	2,480	.....	59	4.22	6,616	0.0
121	85	41.0	14.5	6,178	1.4	1,630	10	1,212	165	.....	2.94	4,976	0.0
89	87	39.0	14.0	4,851	1.2	1,857	77	1,145	705	.....	2.36	5,709	100.0
124	98	26.0	12.0	8,668	1.4	2,069	...	1,243	429	.....	2.39	6,207	0.0
127	98	40.2	15.0	14,015	2.3	2,554	...	2,377	758	.....	1.82	6,182	42.9
104	100	45.5	12.0	6,990	1.9	1,455	...	1,768	421	.....	4.25	5,359	0.0
123	100	46.7	10 5	7,544	1.2	1,068	75	894	.....	88	3.77	5,313	0.0
103	100	25.8	13.0	3,594	1.2	1,643	20	1,082	831	.....	2.99	5,326	100.0
144	100	51.0	11.5	7,162	2.1	1,400	...	1,876	45	.....	3.58	5,691	0.0
101	103	32.2	13.5	5,135	1.2	1,557	154	973	764	.....	2.10	5,275	0.0
129	109	34.5	15.5	7,604	1.2	1,476	...	1,794	4	.....	3.12	4,298	0.0
148	110	46.0	18.5	12,106	2.4	2,413	10	2,543	.....	830	3.33	5,684	50.0
116	112	45.5	19.5	7,459	1.3	2,010	40	1,358	397	.....	2.98	4,665	100.0
139	119	46.0	31.0	16,818	2.5	4,023	...	3,099	.....	364	2.21	5,607	60.0
130	122	25.5	24.5	11,548	2.1	3,749	8	3,123	540	.....	2.07	6,527	0.0
115	123	35.0	16.0	7,875	1.5	2,686	60	2,359	230	.....	2.66	6,530	0.0
110	126	52.2	14.5	9,611	2.5	3,037	...	2,274	350	.....	2.37	9,066	71.4
137	126	51.3	19.0	15,302	2.5	2,554	19	3,450	.....	1,089	3.65	5,956	50.0
145	130	56.2	20.0	14,435	1.3	2,251	140	2,491	1,358	.....	2.53	4,884	50.0
156	140	56.0	21.0	7,722	1.0	2,284	...	2,310	837	.....	2.39	4,317	0.0
114	140	54.0	17.5	10,995	2.1	1,944	...	1,828	583	.....	2.77	4,860	0.0
100	140	42.0	20.0	8,422	1.7	2,874	100	2,526	322	.....	2.19	6,541	0.0
128	148	60.0	21.5	8,561	2.0	2,797	110	1,030	970	.....	2.45	5,426	0.0
98	155	56.0	29.5	13,944	3.0	3,823	262	4,262	1,111	.....	2.50	5,833	0.0
120	156	48.5	14.5	6,764	1.7	1,442	...	776	604	.....	2.99	4,390	0.0
154	156	30.8	22.0	7,056	2.2	3,344	...	2,784	542	.....	2.10	7,363	0.0
107	160	66.5	19.0	6,737	2.8	1,247	40	2,078	.....	557	4.11	3,285	0.0
152	162	56.5	30.5	13,487	1.9	5,531	...	4,003	2,266	.....	1.94	7,340	61.5
84	165	60.0	31.5	17,269	2.4	4,507	185	2,784	1,375	.....	2.08	5,996	50.0
90	169	69.0	32.5	18,802	2.1	5,926	...	7,121	.....	1,679	2.69	8,224	100.0
94	169	49.5	21.5	10,336	2.3	2,056	...	2,482	.....	600	3.19	4,260	0.0
113	172	54.0	26.5	20,136	2.5	3,788	34	2,651	806	.....	2.24	5,544	100.0
91	172	56.0	25.0	9,854	3.2	3,591	50	5,186	.....	815	3.10	6,100	0.0
146	175	35.5	15.5	8,837	1.3	2,662	...	1,789	976	.....	2.65	6,103	0.0

TABLE 89 (*concluded*)

Farm number	Acres operated	Acres of crops	Number of cows	Average total capital	Man equiv-alent	Milk sales	Crop sales	Farm expenses	Plus labor income	Minus labor income	Cow cost of milk per hundred-weight	Pounds of milk produced per cow	Per cent of cows added by purchase
159	175	79.5	18.5	$8,564	1.5	$1,940	$ 37	$1,422	$659	.....	$3.48	4,910	0.0
155	175	51.7	23.0	9,326	1.6	2,923	45	2,324	170	.....	2.51	5,517	0.0
112	176	55.0	26.5	16,723	2.2	4,217	...	2,485	1,031	.....	2.23	6,940	66.7
161	180	82.0	17.5	8,986	1.5	1,914	...	1,665	342	.....	3.49	4,581	100.0
132	180	95.5	31.8	31,690	3.2	5,517	50	5,601	.....	$336	2.36	7,642	75.0
160	181	68.5	18.0	8,343	2.2	2,386	...	1,869	371	.....	2.01	5,516	100.0
106	185	66.0	29.5	10,259	2.1	3,977	...	2,364	1,921	.....	2.23	5,939	0.0
85	187	54.5	34.0	16,144	2.5	5,252	28	3,625	837	.....	2.50	6,174	100.0
111	188	53.8	26.0	17,179	2.0	4,963	30	3,135	581	.....	2.38	7,186	100.0
95	190	74.0	25.0	12,368	2.9	2,874	...	2,602	.....	581	2.86	5,048	0.0
119	194	59.5	41.5	12,756	2.8	4,977	27	3,116	1,229	.....	2.20	4,629	40.0
92	200	50.5	26.0	12,769	2.1	4,337	...	2,708	678	.....	2.26	7,266	100.0
122	200	85.5	18.5	5,946	2.5	2,226	200	2,196	.....	482	3.39	4,483	0.0
141	200	125.5	23.5	19,121	2.0	1,783	16	3,104	.....	2,495	4.23	3,477	70.0
133	208	51.0	19.5	10,276	2.3	2,655	...	2,806	398	.....	2.95	5,875	28.6
109	209	58.8	26.5	15,258	2.2	3,834	121	3,771	400	.....	2.72	6,766	0.0
126	215	98.0	21.5	12,352	2.3	3,484	5	2,391	965	.....	2.21	6,851	60.0
105	219	66.5	30.0	15,096	2.6	2,851	...	3,920	.....	1,753	4.25	3,836	92.9
167	220	64.5	17.5	9,239	1.7	1,421	60	2,111	.....	1,470	4.25	4,310	77.8
99	246	71.0	10.5	9,168	2.1	2,498	281	2,257	1,048	.....	3.03	10,509	57.1
117	250	69.0	23.5	17,048	2.4	2,569	200	3,082	.....	893	3.52	5,024	20.0
151	252	77.8	33.0	14,872	2.8	5,072	87	3,840	373	.....	2.55	6,525	100.0
143	265	74.0	39.5	17,171	2.8	5,689	75	4,058	1,555	.....	1.70	6,114	0.0
149	267	125.0	49.0	24,264	3.4	6,497	130	6,271	584	.....	2.65	5,990	0.0
134	272	92.5	34.0	10,606	1.7	2,814	20	2,138	.....	111	3.23	3,804	0.0
138	277	94.2	40.5	20,952	3.3	6,005	60	5,176	395	.....	2.59	5,697	40.0
131	278	78.0	30.0	20,446	1.8	2,927	230	2,763	.....	640	3.18	4,530	100.0
142	280	56.5	27.0	12,751	1.9	3,141	82	2,232	718	.....	2.77	5,318	0.0
135	297	97.5	36.0	13,549	2.4	2,884	300	3,817	.....	677	2.98	3,874	0.0
165	298	83.5	29.0	9,929	1.5	3,535	...	2,095	510	.....	2.91	5,497	0.0
86	300	82.0	34.5	25,400	3.2	6,533	110	5,174	415	.....	2.45	8,572	80.0
163	300	71.5	40.0	24,482	3.0	4,342	50	4,685	.....	286	2.48	4,649	88.5
162	301	130.0	26.5	7,222	2.7	2,667	100	3,562	85	.....	2.79	4,541	0.0
87	310	84.0	34.0	11,140	1.5	4,778	4	2,280	2,019	.....	2.38	5,502	0.0
97	385	102.0	32.0	19,238	4.0	3,677	170	4,320	.....	236	2.72	5,556	50.0
166	392	176.0	58.5	32,059	3.4	6,675	12	5,990	1,453	.....	2.02	5,307	0.0
147	400	71.0	38.0	21,000	3.6	4,904	112	3,759	1,291	.....	1.85	5,855	0.0
158	400	76.8	23.0	9,716	1.9	2,244	25	2,192	62	.....	2.08	4,446	80.0
150	400	124.0	48.5	18,821	3.2	6,556	10	3,592	1,699	.....	1.74	6,033	0.0
136	435	167.0	68.0	41,274	4.5	9,342	913	8,390	.....	276	2.42	5,853	61.9
157	500	120.5	45.5	21,614	1.6	6,063	370	2,361	3,449	.....	2.27	5,850	0.0
153	600	111.5	48.0	30,921	4.8	6,222	256	8,057	.....	1,315	2.47	5,441	0.0

TABLE 90. IMPORTANT BUSINESS FACTORS FOR 51 TULLY AND HOMER FARMS

(Arranged according to size of farm operated)

Farm number	Acres operated	Acres of crop	Number of cows	Average total capital	Man equivalent	Milk sales	Crop sales	Farm expenses	Plus labor income	Minus labor income	Cow cost of milk per hundredweight	Pounds of milk produced per cow	Per cent of cows added by purchase
198	62	39.0	12.5	$13,004	2.2	$ 1,084	$2,652	$ 2,323	$1,306	.....	$3.67	3,779	0.0
175	71	59.0	12.0	7,636	1.2	1,904	388	1,350	847	.....	3.55	6,886	100.0
201	75	46.0	32.5	19,992	2.7	5,855	3,289	6,592	3,619	.....	2.73	6,493	28.6
174	80	50.0	12.0	10,181	1.3	2,048	1,735	2,478	1,925	.....	2.89	6,510	0.0
180	90	58.0	17.0	12,141	2.7	1,620	1,250	3,352	.....	$ 338	3.27	4,240	0.0
186	90	41.0	20.0	18,814	1.5	1,476	300	1,953	.....	800	3.22	3,696	0.0
184	90	54.5	11.0	10,850	1.7	1,943	2,005	2,181	2,849	.....	2.01	8,028	50.0
214	94	44.0	22.0	22,850	2.0	2,559	1,975	2,797	2,188	.....	3.55	4,576	0.0
191	100	58.0	15.0	11,364	2.0	2,108	1,490	2,538	227	.....	3.57	6,314	40.0
213	100	44.0	16.5	13,496	1.9	2,820	1,125	2,177	1,179	.....	2.84	6,928	0.0
171	106	51.0	13.5	11,978	1.7	2,329	182	2,389	.....	275	2.46	8,533	0.0
207	107	56.0	25.0	12,428	1.8	4,015	1,340	3,332	2,208	.....	2.94	6,083	28.6
210	110	46.0	36.5	26,785	2.3	8,351	948	5,732	3,629	.....	2.06	8,080	100.0
183	113	62.0	15.5	12,160	2.1	2,263	915	1,820	839	.....	2.73	6,500	0.0
203	114	55.0	29.5	14,938	3.8	4,326	1,050	4,637	620	.....	2.26	5,494	0.0
217	116	89.0	42.5	36,628	4.0	11,298	2,280	6,271	4,466	.....	2.51	8,968	100.0
181	131	59.0	10.0	8,191	2.2	1,164	1,050	1,919	293	.....	2.62	5,974	0.0
188	138	65.0	15.0	13,470	1.9	2,169	2,146	3,403	1,572	.....	2.96	6,096	71.4
185	139	101.0	14.5	13,354	3.0	1,803	1,798	2,829	630	.....	2.50	6,133	0.0
197	140	75.0	19.5	12,396	2.8	2,815	1,009	4,310	.....	1,079	3.51	6,875	100.0
219	141	55.4	34.0	22,858	2.5	7,031	941	4,969	2,401	.....	2.29	7,461	100.0
199	148	75.8	27.5	19,149	2.4	4,301	1,854	4,263	2,853	.....	2.11	7,076	0.0
192	150	59.0	18.5	13,408	1.5	2,192	450	1,751	265	.....	3.65	5,184	100.0
209	160	51.0	54.0	31,288	4.6	13,289	710	10,738	2,466	.....	3.03	7,911	100.0
187	160	57.0	17.0	11,468	2.3	2,649	1,321	2,552	963	.....	2.84	6,256	100.0
182	160	62.0	14.5	9,024	1.9	2,288	2,291	1,879	2,854	.....	2.99	6,620	0.0
169	160	57.0	29.0	16,684	2.1	4,226	168	6,185	.....	767	2.57	6,669	20.0
204	167	64.0	17.5	17,806	3.0	1,848	1,404	3,127	.....	1,039	4.46	5,033	100.0
172	170	100.0	37.0	25,428	3.0	4,240	1,186	6,005	.....	882	2.67	5,332	0.0
206	170	75.0	30.0	14,067	2.5	5,345	1,900	3,357	3,221	.....	2.36	6,566	0.0
215	170	75.0	27.5	26,004	2.0	5,515	2,784	3,818	3,527	.....	2.11	6,951	57.1
173	175	77.5	19.5	13,434	1.9	2,527	514	3,606	.....	596	2.77	5,615	0.0
205	179	63.0	24.0	14,388	3.0	2,723	1,730	3,883	.....	373	4.02	5,130	40.0
218	181	54.0	35.5	23,072	2.0	4,667	1,050	3,803	1,146	.....	2.38	5,723	40.0
176	184	94.0	22.0	22,120	2.2	2,862	3,559	9,801	146	.....	2.99	6,158	0.0
208	200	79.0	60.0	32,085	3.8	12,217	1,320	11,527	1,731	.....	3.63	6,673	100.0
194	200	74.0	17.5	26,978	2.8	3,476	2,781	5,555	567	.....	3.75	7,453	25.0
170	208	93.0	23.5	23,969	2.0	3,365	250	5,360	.....	291	4.86	6,097	100.0
212	210	89.0	26.0	49,650	2.8	3,988	1,889	5,955	.....	266	2.57	6,240	87.5
179	210	105.0	30.5	19,368	2.6	6,334	3,065	6,293	2,820	.....	2.20	7,977	60.0
200	211	95.0	45.5	24,034	4.2	10,181	1,254	7,959	2,671	.....	2.01	7,195	100.0
178	212	81.5	18.5	10,337	2.6	2,171	800	3,107	.....	513	3.37	5,606	66.7

TABLE 90 (*concluded*)

Farm number	Acres operated	Acres of crops	Number of cows	Average total capital	Man equiv-alent	Milk sales	Crop sales	Farm expenses	Plus labor income	Minus labor income	Cow cost of milk per hundred-weight	Pounds of milk produced per cow	Per cent of cows added by purchase
211	213	60.0	37.5	$30,479	3.2	$5,127	$3,740	$6,079	$4,871	.....	$1.99	6,305	77.8
189	220	151.0	23.5	23,950	2.7	3,762	5,281	6,096	4,171	.....	1.92	7,180	100.0
193	228	110.0	11.5	12,857	3.3	2,411	1,596	4,651	.....	1,114	3.30	8,402	0.0
177	232	98.0	22.0	20,308	3.5	3,432	3,326	5,885	96	.....	2.65	8,009	0.0
190	271	127.0	30.5	15,931	4.8	4,296	1,718	12,512	.....	2,807	3.58	6,084	0.0
216	278	57.0	28.0	20,422	2.1	2,659	1,030	3,595	.....	105	3.32	4,527	93.1
202	304	67.0	30.0	17,774	1.8	2,652	1,355	3,423	704	.....	2.82	4,032	16.7
195	325	179.0	22.0	36,346	3.2	2,551	1,485	4,574	.....	1,329	3.87	5,142	0.0
196	514	204.0	48.5	32,044	3.3	4,026	3,540	5,317	951	.....	1.94	3,766	100.0

SUCCESSFUL FARMS

In Bulletin 421 no discussion of successful farms was made, as there were only three farms that showed labor incomes of over $1000. In the two areas reported here there were 36 farms with labor incomes of over $1000 each. The important business factors for four of the most successful farms are given in table 91:

TABLE 91. BUSINESS FACTORS FOR SOME SUCCESSFUL FARMS WITH CASH CROPS FOR THE YEAR ENDING APRIL 30, 1922

Farm number	179	217	189	201
County	Onondaga	Cortland	Onondaga	Cortland
Village	Otisco	Homer	Tully	Homer
Labor income	+$2,820	+$4,466	+$4,171	+$3,619
Cost of milk per 100 pounds	$2.20	$2.51	$1.92	$2.73
Price received for milk	$2.63	$3.01	$2.29	$2.94
Gain per cow	$34	$44	$25	$13
Size of business:				
Acres operated	210	116	220	75
Acres of crops	105	89	151	46
Number of cows	30.5	42.5	23.5	32.5
Number of men, including operator	2.6	4.0	2.7	2.7
Capital	$19,368	$36,628	$23,950	$19,992
Hundredweight of milk sold per farm	2,404	3,749	1,646	1,989
Type of business:				
Milk receipts	$6,334	$11,298	$3,762	$5,855
Crop sales:				
Potatoes	$1,300	$225	$1,210	$135
Cabbage	$1,520	$1,000	$3,600	$3,154
Hay	$240	$255	....	....
Straw	....	$300	....	....
Oats	....	$500	....	....
Buckwheat	....	....	$270	....
Wheat	....	....	$184	....
Per cent of cows freshening from September to December, inclusive	52	55	44	62
Per cent of cows four years old or younger	38	0	0	20
Acres of crops per animal unit	2.3	1.8	5.3	1.1
Rates of production:				
Pounds of milk produced per cow	7,977	8,968	7,180	6,493
Crop yields:				
Corn for the silo (tons)	11.6	18.6	14.9	15.1
Alfalfa (tons)	3.0	....	....	4.2
Other hay (tons)	1.5	3.4	1.0	3.0
Potatoes (bushels)	139	250	125	210
Cabbage (tons)	10.1	6.7	12.0	20.0
Feeding:				
Pounds of concentrates per cow	1,639	2,127	1,196	2,538
Pounds of silage and other succulent feed per cow	13,836	12,000	10,553	10,092
Pounds of dry forage per cow	2,623	4,612	1,872	3,077
Per cent of protein in grain concentrates	23.0	20.2	22.2	18.9
Price per ton for concentrates	$44	$50	$45	$33

TABLE 91 (*concluded*)

Farm number	179	217	189	201
County	Onondaga	Cortland	Onondaga	Cortland
Village	Otisco	Homer	Tully	Homer
Acres of crops grown:				
Corn for the silo	25	14	8	9
Oats	23	27	55	11
Alfalfa	19	....	....	15
Other hay	21	40	43	5
Potatoes	10	1	12	1
Cabbage	5	6	10	5
Buckwheat	....	....	10	....
Wheat	....	....	9	....

Farm 179 is located on what is probably Ontario soil, on the hills, 8.5 miles from market. It is a successful business primarily because of a moderately large dairy of high-yielding cows and a large acreage of potatoes and cabbage which sold at high prices. Concentrates were relatively cheap. The outstanding features of this business are the large acreage of cash crops and the high-producing cows. From the standpoint of milk output, it is only moderately large.

Farm 217 gave the second largest labor income ($4466) of the Tully and Homer group. The farm comprises 116 acres and has 43 cows. Besides milk sales of $11,298, this farm sold: oats, $500; straw, $300; hay, $255; potatoes, $225; cabbage, $1000; sirup, $175 — a total of $2455 for crop sales. Three hired men, besides the operator, worked on the farm. The total capital was $36,628. Milk amounting to 187 tons was sold at an average price of $3.01 per 100 pounds including premiums. The outstanding features of this business are: the intensity of the business, high yields of cows, high yields of all crops except cabbage, and a large output of milk from a limited area. The soil is the Fox gravelly loam, which is naturally very productive, and on this farm, particularly, it has been heavily manured for years. High prices for milk also contributed to the success of the business.

Farm 189 is an upland farm with a large acreage of crop land but with a small dairy. Its success is due in large measure to the high prices realized for cabbage and potatoes. The milk was pooled, and the price is therefore less than on the other farms here considered. Costs of production were kept down by light feeding of very good cows. In a year of low crop prices this farm would not rank so high as the two preceding ones.

Farm 201 is a very intensive and productive small valley farm. This farmer purchased 89 acres in March, 1922, making the size of his farm 164 acres. His plan of development has been to first intensify and handle well a small farm, then to extend operations, a very safe procedure in farm development.

Recent publications on dairy farming by the same author, from the New York State College of Agriculture, are:

Calculating the cost of milk production. Reading-Course Lesson for the Farm, No. 142. 1919.

An economic study of dairying on 149 farms in Broome County, New York. Cornell Univ. Agr. Exp. Sta., Bulletin 409. 1922.

Relation of the composition of rations on some New York dairy farms to the economics of milk production. Cornell Univ. Agr. Exp. Sta., Memoir 64. 1923.

Economic studies of dairy farming in New York. I. Condensery milk without cash crops. Cornell Univ. Agr. Exp. Sta., Bulletin 421. 1923.

An economic study of dairying on 163 farms in Herkimer County, New York. Cornell Univ. Agr. Exp. Sta., Bulletin 432. 1924.